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TECHNOLOGICAL EXAMINATIONS.

THE recent examinations held at the City and Guilds of London Institute and at the South Kensington Science Schools, show that the interest felt in electrical work by the rising generation is on the increase. Severe as has been the depression resulting from the late electric light mania, the progress in electrical science as applied to the arts, continues to be steady, and promises to afford an opening for employment to a very large number of individuals.

The more complete the knowledge possessed by those who wish to excel in the profession they have chosen, the quicker and more certain will be their advance; this knowledge can only thoroughly be attained by a course of careful and properly directed study tested by well-conducted examinations. To set an examination paper which shall correctly test a pupil's ability and knowledge is by no means so easy a task as at first thought might be imagined, and there is often very much to be found fault with in the style of questions asked. Too often the examiner appears to endeavour to determine the knowledge which the pupils do not, and not what they do, possess, the result being great discouragement to the examinees.

The questions set for the South Kensington examination leave little to be desired—they are decidedly good—being of such a nature as to fairly test a student's reasoning powers and to show whether his knowledge is sound and not obtained by a mere "cramming" process. The last two questions for the Honours grade are thoroughly practical, a somewhat unusual circumstance in a paper set by Professors, whose work is almost purely in the domain of theory. A very free use is made of numerical values in the questions, a point which is much to be commended. Altogether, Profs. Guthrie and Carey Foster may be said to have set a description of questions which might be imitated in many cases with advantage.

Turning now to the City and Guilds of London Institute, we are not so satisfied; the questions in "Telegraphy," however, must be excepted, as they are in almost every case decidedly to the point, though in one or two solitary instances the questions are more suited for an electricity examination; a few more sketches of instrument connections, also, might have been asked for with advantage. The elementary paper ought certainly to encourage the student, whilst the Honours questions are not too difficult, and cover a fair range of ground.

With regard to the "Electric Lighting and Transmission of Power" paper, we would point out that the ordinary grade is professedly for apprentices (juniors) and engineering students in the country; most of those who attend classes are young engineers, who hope by picking up some information about the *details* and construction, as well as simpler theories of the subject, to get employment after their apprenticeship is over, and consequently they are floored and disappointed by a set of purely theoretical questions. As such students only get some 30 lectures in a session (of evening classes), most of the time is occupied in explaining apparatus, but in the examination paper we have not a single question about the electrical details of incandescent or arc lamps, dynamos, motors, ampère or volt meters, &c., and there is no attempt to bring out powers of sketching the connections of testing arrangements, or of machines, or of constructing and erecting plant. Indeed a man might answer the questions in the paper without having seen a dynamo or an electric light, whilst, on the other hand, another man, who knows a great deal about fitting up an installation and working the same might fail to pass. A certificate of having satisfied the examiners in this particular paper would not get a man a situation as an electrical engineer with any ordinary company. Examinations of such a character as that under consideration would, we feel sure, act as regular dampers, and tend to prevent students coming forward; the latter would rather work for the Telegraphy examination.

Again, the questions are of a decidedly indefinite character; take, for instance, question 9 in the ordinary grade, viz:—"A room containing 60 lamps, each requiring 80 volts, is at a distance of 200 yards from the dynamo; what must be the diameter of the copper of the main leads so that the potential difference at the lamps is not less than the potential difference at the terminals of the dynamo by more than 1 per cent.—1st, when the lamps require 45 volts; 2nd, when they require 110 volts? One yard of commercial copper wire, one square inch in section, has 0·00002435 ohms resistance." We should like to know why lamps at one time require 80 and at another 45, and then 110 volts. Again, in the Honours grade we have question 6, viz:—"Describe in detail the various systems that have been devised for *economically* supplying electric energy to a large district of houses without the potential in any one house being made to exceed that of the earth by, say, 150 volts. Which of these systems would you practically adopt, and why?" Now the matters here referred to have never been properly tried, in this country at least, and, therefore, the question is, to say the least, superfluous. In one case several independent questions have been grouped together as one question for no apparent reason.

Although we have somewhat warmly criticised the paper we do not mean that good and fair questions have not been set, but sufficient care has certainly not been taken to gauge the same to the ability of the students, nor to encourage the latter.

In conclusion, it seems advisable to draw attention to a serious matter, which we had very nearly overlooked; we would point out that we consider it most undesirable that any Professor whose students compete in an examination should be allowed to set the examination questions. We doubt not but that all our unbiassed readers will agree with us at least in this very important factor in a fair and just technological examination.

EXPERIMENTS ON THE DISCHARGE OF ELECTRICITY THROUGH GASES. SKETCH OF A THEORY.*

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Abstract of Royal Society's "Bakerian Lecture," read June 19th, 1884.

IN the following pages I give an account of several new phenomena, some of which have a direct bearing on the theory of the discharge of electricity through gases. Although I hope that the experiments may be judged independently of any theory, their description may be rendered a little more clear and interesting if I begin with a short explanation of the theoretical views to which they seem to me to point.

These theoretical conclusions will be looked at favourably, I think, by those who have been trained up with the ideas of Faraday and Maxwell; for they must have always considered it likely that the conduction of electricity through gases is more probably due to something resembling the electrolytic conduction in liquids than to the direct passage of electricity from one molecule to another. My experiments with mercury vapour argue very strongly in favour of this view.

Fundamental Points of the Theory.

I know, from private conversations, that many of those well able to judge consider some electrolytic action in a gas as probable whenever an electric discharge takes place through it. But owing to the want of experimental evidence, no doubt, very little has been published bearing on this point. Mr. J. J. Thomson † has recently supported this view. His ideas are of utility for the explanation of some phenomena attending the spark discharges, but they furnish no clue towards the explanation of the asymmetry of the glow discharge, and of some appearances which by many are considered as characteristic and fundamental in the passage of electricity through gases. No consistent attempt towards a systematic theoretical discussion of these facts has yet been made.

I am afraid that I can offer only a very crude beginning of such a discussion, but I have sufficient confidence in the correctness of its fundamental views to submit them to the judgment of the scientific public. I shall avoid as much as possible all suppositions and hypotheses which cannot be put to the test of experiment; but it seems necessary to start with some assumption, in order to avoid too great a vagueness in the subsequent explanations. The assumption which I shall make is this:—In a gas, the passage of electricity from one molecule to another is always accompanied by an interchange of the atoms composing the molecule. I have been much struck with the results of some experiments recently made by Mr. L. J. Blake in Professor Von Helmholtz's laboratory, investigating the vapours rising from the surfaces of warm liquids which were kept charged to a high potential; he found that these vapours were entirely unelectrified. Different liquids were tried—such as pure water, water containing salts in solution, and mercury. Now, if it is found that the vapour actually rising from an electrified liquid is not electrified, can we imagine that a molecule striking an electrified surface in its rapid motion should carry away with it any part of the electricity, or that one molecule should be able to communicate electricity to another in an encounter? Assuming that we cannot, we are led at once to the supposition that the discharge in gases is accompanied by a breaking up the molecules. But this does not seem to me to be quite sufficient to account for all phenomena, and especially for those involving stratifications. There is reason to think that the formation of unstable compounds, such as ozone, play an important part in the glow discharge. They are very likely essential to the production of stratifications.

The test of any theory must be found in the numerical results it is capable of giving. Hitherto, however, the qualitative phenomena have not, in my opinion, been sufficiently separated from the great number of disturbing effects to allow us to give a decisive value to quantitative measurement. Though I shall not discuss the few measurements which I have been able to make, I shall point out where numerical results can be most easily obtained by the theory and tested by experiment. I do not pretend to explain all the phenomena of the discharge, but I shall attempt to show that there is no distinct contradiction between the theory, in favour of which I argue, and the facts; that is more than can be said of any other theory that has been proposed. I shall try to prove in the present paper that the molecules are, in all probability, broken up at the negative pole.

Experiments with Mercury Vapour.

According to the kinetic theory of gases, the molecule of mercury vapour consists of a single atom, which is incapable of vibration. Mercury has a very brilliant spectrum, which proves that the theory is incomplete in some important point. It is well known, on the other hand, that the theoretical conclusion receives support from the fact that the vapour-density of mercury vapour is anomalous. If, as is generally supposed, the molecule of the majority of gases contains two atoms, that of mercury can only contain one. At any rate, we are justified in asserting that the molecule of mercury vapour has a simpler composition than that of most gases. If, then, an essential part of the glow discharge is due to the breaking up of the molecules, we might expect mercury vapour to present other and much simpler phenomena than the gases with which we are generally accustomed to work. *This, indeed, is the case; for I find that if the mercury vapour is sufficiently free from air, the discharge through it shows no negative glow, no dark spaces, and no stratifications.* In view of the importance of the fact, I have paid a good deal of attention to this point, and, in spite of some experimental difficulties, I have considerable confidence that the statement which I have made is true.

It is needless to describe all the tubes used and the experiments made. I have varied the conditions of the experiments in many ways, but always with the same result. When the air is sufficiently expelled, the spark does not break through the tube at the ordinary temperature; when the mercury is heated the discharge passes, but always in a perfectly continuous stream, joining the positive and negative electrode. It is difficult to prevent small bubbles of mercury from condensing on the surface of the glass, and the absence of dark space and glow might be explained by the irregularities thus introduced, but I think the following observations conclusive in this respect.

The mercury in the tube would always at first contain small bubbles of air between it and the glass, and these could be purposely left, say, on one side, by volatilising the mercury always on the other. One tube in this way could be prepared which, with a small but visible bubble on one side kept down by the mercury did not allow the discharge to pass. If the mercury was heated without disturbing the bubble, the current passed, illuminating the tube with a perfectly continuous stream of light. As soon, however, as the bubble was driven into the tube, a perfectly distinct and clear dark space became visible at once.

It is more difficult to prevent stratifications than to prevent the dark space and glow. A mixture of air and mercury shows beautiful stratifications. When the air is expelled as much as possible, I never saw stratifications while the tubes were attached to the pump, but in order to study the phenomena a little better I sealed off some of the tubes and heated them up either in a steam or paraffin bath, so as to give them the same temperature throughout. It is then that the stratifications are very apt to occur at a temperature of 100° C., when the tension of mercury vapour would, according to Regnault, be three-quarters of a millimetre. The extreme difficulty, however, of excluding all traces of air easily explains this, while the irregularity of the phenomenon and its absence in the experiments, which were carried on with the greatest care, seem to me to be conclusive in proving that pure mercury vapour never shows any stratifications, for the experiments were continued until the tension of mercury vapour was 20 millims.

I have reason to think that the vapour of sodium resembles that of mercury, and does not show any dark intervals. From the fact that at the temperature of the spark, sodium shows its line spectrum instead of the bands, we may conclude that we have also to deal in that case with a monatomic molecule.

Evidence of Dissociation during the Discharge.

There is very strong spectroscopic evidence that gases through which an electric current is passing are always in a state of rapid dissociation. Thus I do not know of a single case in which the gas during the glow discharge does not show two, or generally even three, distinct spectra. This dissociation seems especially strong in the negative glow. The characteristic spectrum which gases, as a rule, show in the neighbourhood of the negative electrode bears evidence of belonging to a complex molecule, but at the same time a high temperature line spectrum is always seen to overlap the bands. I have shown some time ago that the spectrum of the negative pole cannot be explained by mere peculiarities of temperature, and, further, that it must be due to the formation of a distinct molecule. as the spectrum keeps its original place even a short time after the current has been reversed.

As the subject is one that is not much studied, I may be permitted to give here a short account of the spectral phenomena seen in tubes filled with different gases.

Nitrogen.—This gas shows in the positive half a well-known complicated *band* spectrum. The glow shows peculiar bands, but the strongest nitrogen *lines* are also always visible, and it is generally only there that the lines are seen. The capillary part will only show lines when its bore is very small, as, for instance, when a piece of thermometer tubing is used. As the bands of the positive half are also seen in the glow, this region shows the superposition of three distinct spectra. There is at present no longer any doubt that this means the superposition of three distinct sets of molecules.

Oxygen shows phenomena exactly corresponding to those in nitrogen. The positive part shows what I have called the complex line spectrum, which stands, as regards character, in a remarkable way between a line and a band spectrum. The negative glow shows characteristic bands, and at the same time both the spectrum of the positive pole and traces of the high temperature line spectrum of oxygen. Here, again, we have three distinc sorts of molecules in the glow. The phenomena in *hydrogen* are not as yet so well ascertained. The positive half and also the

* I have not in this preliminary paper been able to do full justice to those to whose labours I think it is chiefly due that this subject has become ripe for theoretical deduction. I may mention here the names of De La Rue and Müller, Crookes, Goldstein, Gustav Wiedemann and Rühlmann, and Eilhard Wiedemann; but the two authors whom I have most often found it necessary to consult are undoubtedly Faraday and Hittorf.

† "Phil. Mag.," June, 1883.

glow show generally a band spectrum which now is generally ascribed to hydrogen; but, at the same time, the lines are very strong. I do not know whether a peculiar spectrum has ever been noticed or looked for at the negative pole, but, owing to the complexity of the band spectrum, it would be rather difficult to discover. No gas shows greater difficulties of purification, and therefore the spectroscopic appearances are much more doubtful in this than in the other gases.

Carbon compounds show their characteristic spectra whenever they are not very rapidly decomposed; but at the same time they always show, at least in the negative glow, the true carbon spectrum. I have already previously drawn attention to the very suggestive fact that the compounds in which the molecules are made up of two, or more carbon atoms (cyanogen, hydrocarbons) give the carbon bands, while those containing only one atom (carbonic oxide) show the true line spectrum of carbon. Angström and Thalén observe that the violet line of carbon is generally visible in tubes filled with carbonic oxide, but I have only observed this line in the negative glow, where it undoubtedly is visible even when no trace of it can be seen in any other part of the tube. I have also observed that tubes filled with carbonic oxide show a band peculiar to the negative pole. Though this observation is nearly ten years old, I have hitherto left it unpublished together with other matter bearing on the same point, as I had hoped to find time to complete my investigations and to write a general description of the spectra of carbon compounds.

I do not think that any of the other gases have been sufficiently well investigated to be noticed here; but some observations which I have made at different times on the spectrum of chlorine confirm the general conclusion which I have drawn.

Messrs. De La Rue and Müller have noticed in some of their experiments a sudden expansion of the gas when the discharge was sent through it. They have proved that this expansion is not due to increased temperature, and a breaking up of the molecules into atoms seems to me to be its next natural explanation.

While we thus have ample evidence of dissociation whenever an electric current passes through a gas, we also find that whatever increases independently the dissociation, improves the conducting power of the gas. Thus we know that a flame is a good conductor, and Hittorf has, in a series of very interesting experiments, shown that if we heat up the electrodes to a white heat, an electromotive force of a few volts will send a current through the gas.

The fact also discovered by Hittorf, that if a discharge is set up, a small electromotive force is sufficient to pass a current across it, is also easily explained by our theory, as the fresh discharge throws the molecules into that state of dissociation which favours the passage of the current.

On the Influence of a Positive Electrode on the Negative Glow.

I now pass to the description of a series of experiments which seem to me to be only capable of explanation by the views brought forward in this paper, and I should like therefore to consider them as crucial experiments which have to be explained by any true theory of the electric discharge.

It was up to recently believed that the form and extent of the negative glow was determined only by the shape of the negative electrode, but was independent of the shape of the vessel or the neighbourhood of another electrode. Goldstein has, however, described some effects of negative electrodes on each other, and E. Wiedemann has recently made an experiment in which some remarkable effects were seen on the approach of the positive electrode to the cathode. Prof. Wiedemann's experiment belongs to the same class as those presently to be described, but differs from mine in so far as it refers to very great exhaustion at which the glow is no longer visible, while I have generally worked at much higher pressures and especially studied the effect on the glow. The peculiarity of the arrangement which I have used consists in the large size of the negative electrode, which allows a much easier observation of the parts at which the negative glow chiefly settles. I shall show that it tends to accumulate *away* from the positive electrode.

The glow which surrounds the negative electrode is divided into three layers which are, however, only clearly separated when the pressure has been reduced to the fraction of a millimetre. The first layer, narrow and closely surrounding the negative electrode, is with new electrodes of a beautiful golden colour. Its spectrum is chiefly made up of the hydrogen and sodium lines. The sodium is evidently due to matter which has settled on the metal, and the hydrogen comes out of the metal where it was absorbed. In time these lines disappear, the layer loses its golden colour, and the spectrum is now that of the positive half of the discharge. The second layer is the so-called dark space. The name is a good one, although Goldstein has pointed out that this layer is only relatively, not absolutely dark. Its luminosity depends much on the gas used. With nitrogen it seems to me to be much darker than with the hydrocarbons. The thickness of this dark space is, according to the measurements of Puluj, about 40 or 50 times as great as the mean free path in air at the same pressure. But the thickness depends on many circumstances, and would not, according to Puluj, be quite proportional to the mean free path at different pressures as we should expect it to be; but measurements of this sort can be only very approximate at present.

The third layer is the glow proper. When the curvature of the electrode is small its inner boundary is sometimes defined with quite a remarkable sharpness, but this also depends on the gas which is used. The outer boundary of the glow extends to different distances, according to the intensity of the current, the size of the electrode, and partly also its shape. It would be useless at present to enter further into the different causes which influence the thickness and definition of these different layers.

The glow is separated from the positive part of the discharge by a non-luminous space, sometimes also called the dark space. In order to prevent confusion I propose the name "dark interval" for it.

I have used in my experiments on the glow a cylinder open at one end. Its internal diameter was 15 centims., its height 38 centims. The open end was closed by means of a brass disc, into which a groove had been cut. The rim of the open end of the cylinder was cemented into this groove. A circular hole, 5·5 centim. in diameter, was cut into the centre of the brass disc, and another glass cylinder was fitted into this hole. The negative electrode was formed by a piece of aluminium foil 8 centims. long, which was wrapped round the inner cylinder. The electrode had a surface, therefore, of over 120 square centims. A long aluminium wire, running parallel to the axis of the aluminium cylinder, formed the positive electrode. The aluminium disc was connected metallically to the brass disc, so that the positive electrode had to be insulated from it. This was done by passing it through a glass tube which passed through the brass, and was cemented into it. This tube also formed the opening through which the exhaustion could be carried on.

At first the discharge, of course, only passes as a spark. It runs irregularly along the wire and passes to the nearest point of the aluminium cylinder. Gradually the glow settles down on the cylinder, if that is negative, as I shall assume it to be. The glow is quite irregular and not always at the same place, but a tendency to avoid the place opposite the wire is already apparent, In fact the effect was first discovered at this stage of the exhaustion. The glow gradually becomes wider. At first it confines itself to the hemisphere which lies towards the positive wire, but it is very irregular in shape. During the first exhaustion it was interesting to notice how on one day there were some spots on the aluminium cylinder, which were illuminated with especial brilliancy by the glow, while on the next the same spots were remarkable by the absence of any glow above them. All these effects depend, of course, on the state of the aluminium surface; gradually this becomes more uniform and the glow more steady.

On exhaustion the glow gradually covers the whole aluminium surface; but a dark strip, about 2 or 3 centims. in width is observed directly opposite the positive wire. I shall refer to the dark strip as the "dark area." As exhaustion proceeds, the glow extends further into the vessel. The dark space surrounding the cylinder becomes more apparent and expands, but the dark area loses its sharpness.

Explanation of the Repulsive Effect of the Positive Electrode on Glow.

The following seems to me a plausible explanation of the phenomenon which I have just described. The rapid fall of potential which is observed on crossing the negative electrode suggests at once, independently of any theory that we have to deal with, the action of a condenser, for we know that no statical charge can produce a finite difference of potential at the electrode, while a double layer will produce a discontinuity. Although it may not be proved that an absolute discontinuity of potential exists at the cathode, it is yet certain that a very rapid fall takes place at that place. This is all that is necessary for the argument.

We recognise such a double layer in the case of electrolytes, but there is an essential difference in the thickness of the layer within which we must imagine that condenser action to take place. In the liquids that thickness must be very small, as is shown by the intensity of the observed polarisation currents. The positively electrified matter in every case is kept against the negative surface by a joint action of electrical and chemical forces, for it has been shown by Helmholtz that only thus can we explain a difference of potential between two bodies. It is the chemical forces which keep the two electricities asunder. The gaseous molecules or atoms, however, subject to their mutual encounters, and always having certain velocities, will tend to leave the surface. They are kept near the surface, however, by the electrical forces, and although I do not, of course, mean to imply that the positive part of the condenser is always made up of the same molecules, but only that the time during which each positively electrified particle forms part of the condenser is large compared to the time during which it would be in the neighbourhood of the electrode if they were both unelectrified.

Suppose, now, that a positive electrode is placed near such a condenser. The resistance of the gas is so much greater than that of the metal electrode that we shall assume the whole electrode to be of the same potential. The lines of force will then cut the surface at right angles, and could we assume the condenser to be infinitely thin there would only be a normal force acting on its particles; but as the lines of force are curved, the particles not in immediate contact with the surface are acted on by a tangential force which will tend to drive them away from the positive electrode. As a steady state will only be possible when the total force is normal throughout the condenser, we arrive at the condition for the steady state that within the condenser the fall of potential must be the same for equal distances measured along the normal to the surface.

Some idea of the distribution of potential may be gained by considering a positively charged point near two concentric spheres, the inner one of which is charged with negative electricity. The outer sphere representing the outer coating of the

condenser will act as a screen; the distribution of the inner sphere will therefore be uniform. The analogy is, of course, not complete, as we cannot assume the positively electrified particles to be distributed over a surface merely.

Our experimental evidence speaks in favour of the conclusion to which we have arrived, namely, that the fall of potential is equal for equal distances taken normally away from the negative electrode. This seems to follow at least from the fact that the boundary of the dark space is, whenever that is possible, equidistant from the electrode. When the electrode is of such a shape that the normal drawn outwards from it meets its surface again, or whenever negative electrodes are near one another, more complicated phenomena arise which we need not discuss here.

Hitherto we have only assumed a certain number of particles positively electrified in the immediate neighbourhood of the negative electrode, and we have left it altogether undecided what these particles are. But if we consider now the fact that the glow does not appear opposite the positive electrode, that is to say, that while the fall of potential is the same all over the surface, the flow is stronger at some places than at others, we are driven to the conclusion that the flow does not altogether depend on the fall of potential, and we must again look for an explanation in the chemical as well as the electric forces. Wherever the fall of potential is chiefly produced by the presence of the positively electrified particles, which I now assume to be the decomposed molecules of the gas, these will help, by their chemical action, to decompose other molecules. Opposite the positive pole the fall of potential is principally due to the nearness of that electrode; chemical forces are absent, and the molecules will not be decomposed. This is, I believe, the explanation of the dark area. And it brings with it the explanation of a large quantity of other facts, as, for instance, the one which has been so long observed and well established, that once a current is set up in the gas it requires a much smaller electromotive force to keep it going. For the discharge, according to us, will generally be introduced by a spark which must give the first supply of decomposed molecules before the continuous glow discharge can establish itself.

The effect of an increase of current on the dark area is also easily explained, but I do not propose to go into details in the present paper.

If my explanation is true, we must expect the glow to be strong between two negative electrodes, and that is the case.

I may, for the sake of clearness, once more mention shortly the principal points of the argument.

The rapid fall of potential in the neighbourhood of the negative electrode renders the presence of positively electrified particles in its neighbourhood necessary.

If the distance through which the condenser action takes place is sensible, the positively electrified particles will be acted upon by a neighbouring positive electrode.

A steady state will be established in which the fall of potential along the normal from the surface will be everywhere the same.

As, however, the flow is stronger away from the positive electrode, we must conclude that other forces besides electrical forces determine the flow.

It is natural to assume that these are chemical forces; that in other words the positively electrified particles are the decomposed molecules, which by their presence assist the decomposition of others, and therefore the formation of the current.

Unless a flaw is detected in this line of argument, I think that the conclusion must be granted, namely, that the decomposition of the molecules at the negative electrode is essential to the formation of the glow discharge. This is really all that I endeavour to support in this paper. The rest can only be settled by further experiments. And amongst the rest I count also the primary cause which originally produces the decomposition of molecules at one pole rather than at another. It is possibly due to an electromotive force of contact between the gas and the electrodes which tends to make the gas electronegative.

The Dark Space and Glow.

Goldstein's experiments described by him under the title of "A New Kind of Electrical Repulsion" are noticed, and their explanation is found to present no difficulties. The most conclusive proof of the view adopted in this paper would be found in the demonstration that the amount of electricity carried by each particle was always the same, whatever the current. We shall only be able to prove by experiment that this is true as an average effect, but this would no doubt be considered sufficient. The author is preparing experiments to test this point in the following way. It was found by Hittorf that the particles proceeding from the negative electrode and projected at right angles to the lines of force of a magnetic field are bent round in a circle. This is as it should be. The radius of curvature of the circle will be proportional to the square of the velocity and inversely proportional to the force which itself varies as the product of the velocity of the particle and the electricity it carries, if the magnetic field is kept constant. The radius of curvature must therefore be proportional to the velocity divided by the quantity of electricity carried. Now I have found that the radius of curvature increases with increasing current, which proves at any rate that the increased electromotive force has a greater influence on the velocity than of the amount of electricity carried. If the amount of electricity varies the velocity must increase in a much more rapid ratio, for the effect on the diameter of the circle is considerable. An increase in the current will, of course, also cause an increase in the number of particles taking part in the discharge, but this does not affect the argument.

Before proceeding further we must consider in what way the velocity itself depends on the amount of electricity carried and on the electric field in the neighbourhood of the cathode. If the total fall of potential within the region in which the particle has acquired its velocity is F, the amount of electricity on it e, v^2 will be proportional to $F e$, and hence the radius of curvature which depends on $\frac{v}{e}$ will vary as $\sqrt{\frac{F}{e}}$. There are a few assumptions made in this deduction, and especially the molecular encounters are neglected, but the assumptions have led to a correct result in the explanation of Goldstein's experiments, and may therefore be accepted for the present. If, then, the radius of the circles should be found to vary with the square root of the total fall of potential, the theory here adopted would be raised to the rank of certainty. It will be interesting to compare the radii of these circles in different gases, and we may perhaps hope to find laws as interesting and more fundamental than Faraday's laws of electrolysis.

A series of further experiments are then entered into which show that the carriage of electricity in the neighbourhood of the cathode does not proceed in the direction of the lines of force, and that therefore the particles must be projected with considerable velocity. These facts have already been established by previous experimenters, but the author's observations show in addition that the negative glow acts as negative electrode as far as the regular positive discharge is concerned. This explains Hittorf's experiment in which the positive electrode is situated within the dark space; the discharge passing in this case from it in a straight line away from the cathode, that is, towards the nearest point of the glow.

The Positive Part of the Discharge.

I have called in this paper, for sake of convenience, that part of the discharge which lies directly adjoining the positive pole "the positive part," without, of course, meaning to imply that it is bodily charged with positive electricity. According to our view the particles which are charged negative have their velocity of projection gradually stopped within the glow, they are then able to follow the lines of force and diffuse gradually towards the positive pole, but the diffusion is in great part electrolytical, that is to say, decompositions and recombinations frequently take place. At first the boundary of the glow being large, the cross section through which conduction takes place is large and the heat produced insufficient to render the molecules luminous; further on the discharge contracts and sends out light. If the negatively charged atom can combine with the remainder of the gas, as in the case of ozone or some of the compound gasses, the electricity in the positive discharge will be carried out by two sets of molecules, the decomposed atoms and the compounds; owing to the encounters dissociation of the compounds will take place, and there will therefore be some definite average time during which the atom will either be single or united to a molecule. And as all the atoms start from the same place, and travel with average rates towards the positive pole, space will be periodically divided into places where the greater number of atoms are single and into places where they are combined. This may possibly account for stratifications, for it is known that these appear chiefly in compound gases, that their form altogether depends on the nature of the gas, that their position at the same density only depends on their distance from the negative pole, and that both stratifications and intervals widen out at reduced pressures. It is quite possible that this explanation will prove insufficient; my purpose here is not to ask scientific men to adopt it, but simply to show that the theory seems capable of dealing with these questions. From Hittorf's experiments that the fall of potential in the positive part of the tube is independent of the current, it is concluded that here a stronger current only means a larger number of particles taking part in the discharge.

Phenomena seen on Reversal of Currents.

The large vessel which I have described shows some curious phenomena when the current is rapidly reversed. If the wire is negative, the cylinder positive, and if the direction of the current is suddenly changed, the dark area does not form at once to its full extent, but a faint glow at first seems to settle on it and only gradually to recede. If the current after the full formation of the glow is interrupted for a few seconds and then sent in the same direction, the dark space will at once be seen dark and to its full extent; but a single spark in the reverse direction will at once produce the unsteadiness. If the current is interrupted for a few minutes the same effects are seen as after reversal. This, I think, points again to the condenser action of the negative electrode, which takes time to establish itself, and disappears at once on reversal of current, or gradually with time.

If the cylinder has been negative and the current is suddenly reversed, the yellow stripes previously referred to seem to start from the part of the cylinder nearest the wire, and quickly to move away towards their final position.

Here again an interruption during a few seconds does not produce the effect while an interruption of a few minutes or a spark in the reverse direction does. The explanation of this may be that there is some action (as there must be) on the wire when it is negative similar to that on the cylinder, that the unsymmetrical arrangement of the glow (though being too indistinct to be seen) yet shows a visible effect in determining the place on the positive

cylinder where the discharge crosses it. But also it may be that there is a condenser action to a small extent at the positive pole, and that similar effects to those noticed at the negative. Experiments with the magnet seem to speak in favour of the first explanation; but at the same time observations are noticed which speak in favour of a projection of particles from the positive pole at very low pressures, though in a much smaller degree than that at the negative pole.

On the Effect of the Magnet on the Discharge.

When the large vessel was used with the aluminium cylinder as negative electrode, magnets introduced into the inner cylinder had some unexpected effects. These, effects, however can be explained by the known actions of magnets on electric currents, together with some of the experimental laws which regulate the formation of the glow. When a magnet was introduced so that its axis coincided with the axis of the cylinder, the whole of the glow instead of spreading all over the cylinder now was confined to a ring round the centre of the magnet.

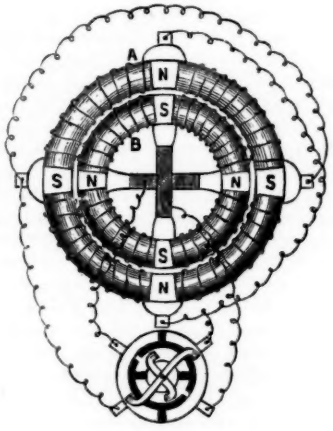
When a small magnet was introduced with its axis at right angles to the axis of the cylinder, dark patches appeared cut out of the glow opposite the poles of the magnet.

This part of the paper also contains some considerations on the action of magnets on the discharge, to which no attention has yet been drawn, but which are of importance in the complete explanation of the different effects which have been observed.

ON A CONTINUOUS CURRENT INDUCTION APPARATUS.

By E. L. VOICE.

THIS apparatus consists of a combination of electro-magnets, or it may be an electro-motor so as to act as an induction apparatus when at rest. Two Gramme rings with (in this case) four pole pieces, are arranged concentrically. The current in the outer ring, A, is directed to develop alternate polar signs resembling an alternating Gramme machine. The outer ring is connected up in parallel. The inner ring, B, is similarly but separately connected up. The two commutators are detached from the machine to facilitate explanation, but in practice it is arranged on the shaft so as to render the apparatus more compact.



The apparatus is supplied by a continuous current which enters by means of the longest brushes pressing on the outer commutator. The outer induction ring is then magnetised and an induced current is set up in the inner ring, which is caught by the second commutators. By a suitable mechanical arrangement the brushes, or commutators, are rotated, when the polarity of the outer ring is reversed as well as the induced current in the inner ring.

It will be seen that the action of the outer commutator converts the continuous initial current into an alternating current, whilst the inner commutator converts the induced alternating current into a continuous one.

A PORTABLE MIRROR GALVANOMETER AND TESTING APPARATUS.

NOW that dire experience in the shape of repeated failures of electric light installations has brought so called electrical engineers and contractors to perceive the necessity of paying attention to the quality and sufficiency of insulation in the leads, apparatus, &c., used for electric lighting purposes, delicate instruments for testing purposes are a *sine qua non* in the daily practice of the profession. Mirror galvanometers consequently must be employed, necessitating the use of lamps, scale, &c., which as at present constructed take up a considerable amount of room, quite out of proportion to their weight, and render an electrician's kit for travelling both inconvenient and bulky.

In some way to meet the want of a more portable form of galvanometer and accessories connected therewith, Mr. A. R. Margary has devised the apparatus of which we give an illustration. For the sake of portability the galvanometer is constructed with the Thomson dead-beat tube, giving a sensibility quite enough for all practical purposes and saving much time in taking readings, a most essential point when measuring the resistance of heated wires.

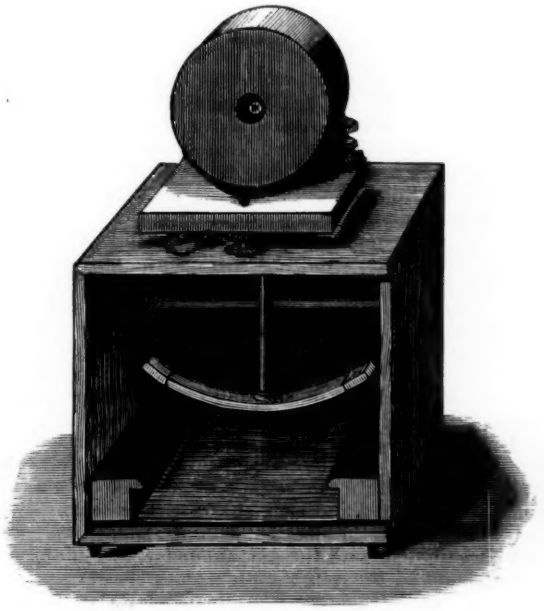


FIG. 1.

The coils of the galvanometer, two in number, are wound, one to a resistance of 6,000 ohms, the other to 100 ohms or as required; the latter, being the outer coil, can easily be got at to make any requisite alteration. The brass frame and case are much heavier than in the ordinary dead-beat galvanometer; the angle-piece carrying the coils and frame is very stiff and weighty, to insure freedom from vibration; it is screwed down on an ebonite base furnished with levelling screws.

There is a double means of controlling the direction of the beam of light from the mirror. For measuring ordinary resistances where rapidity is desirable, two bar magnets of high power can be used for directive purposes, so that the return of the light spot to zero is immediate. For more delicate readings and noting deflections a very slightly magnetised curved magnet, similar to that supplied with all Thomson's reflecting galvanometers, sliding on a brass rod, is fixed to the *under* side of base. The directive force is thus applied in the position best calculated to keep the fibre, by

which the mirror is suspended, perpendicular, and with a fair amount of tension, and tends to cause the mirror itself to be deflected most sensitively as well as to occupy a central position in the tube. The magnet also assists by its action to prevent the disagreeable and troublesome feature of sticking, inherent to dead-beat mirrors as a rule, when directed from the upper side.

The curved magnet works inside the box in which the instrument is packed (this box doing duty as a stand), the brass rod passing through an aperture in the upper side of case and forming at the same time a security against the galvanometer being accidentally pulled off the stand; on the bottom of the stand are three ebonite feet to ensure good insulation and keep the stand steady.

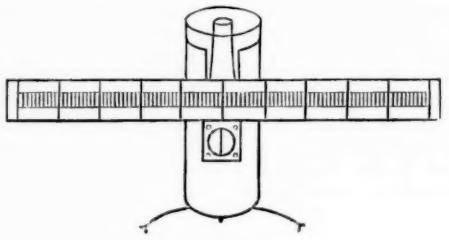


FIG. 2.

In this case are packed a resistance coil of 100,000 ohms, shunts to the 6,000 ohm coil, a short circuit plug, contact key, thermometer and a level, and, if desired, a battery reversing switch and galvanometer reversing key can be added.

The ebonite bases, &c., are left unpolished for greater convenience in scouring.

The external appearance of the lamp and scale when packed resembles a round tin canister. On removing the lid, the magnifying lens and scale and scale carrier will be found inside coiled round the glass of the lamp; to enable the light from the lamp to be raised to a suitable elevation, the lower portion of the canister has an outer case to slide out after the fashion of a telescope mount, and to give a firmer basis, movable legs can be attached; on fixing the lens and scale in their places as shown in illustration, the arrangement is complete and ready for use. It will be seen, the minimum of space is taken when the parts are separated and packed away in its case.

By the aid of the 100,000 ohm resistance coil and shunts supplied with the galvanometer, and obtaining the constant of the same with a given battery power, tests for insulation—superior to those which can be measured by ordinary bridge method—can be made with sufficient practical accuracy.

VOLTA AND MAGNETO ELECTRIC INDUCTION.*

By WILLOUGHBY SMITH, M.R.I.

IT is now thirty years ago that Faraday gave me my first lesson in volta-electric induction, at the same time impressing upon me the fact that physical science must ever be progressive and corrective, and that he was always pleased to learn that his experiments had been repeated by others with a view to their verification or correction. In the remembrance of this I have felt encouraged in coming before you this evening.

Doubtless all present are familiar with the fact that about 1819, Professor Oersted made a discovery which has done much to advance our knowledge with regard to electricity and magnetism. I will now repeat this experiment, as the result obtained will lead up to, and enable you to better understand what I may show later on.

Here is a length of copper wire, from the top surface and centre of which projects a metal pin having, balanced on its point, a magnet. The position of the steel is, as you perceive, parallel with the wire; and that position being north and south, it will thus remain until by pressing down this spring, the length of copper wire is placed in metallic circuit with this battery, and you observe that the steel needle immediately has a tendency to place itself at right angles to the copper wire, remaining thus displaced until the current ceases to flow, when the needle again obeys the influence of terrestrial magnetism and returns to its former position. This was Oersted's experiment which led to the discovery that all bodies possess the qualities of a magnet whilst a current is passing through them. From this fact Faraday conceived the idea that, if a similar length of copper wire were placed parallel with the former one, and close to it, each time the circuit was made or unmade there would be an induced current flowing in this wire, providing it was part of a closed metallic or other conducting circuit.

Through the kindness of Dr. Tyndall I have here the identical spirals which were made and used by Faraday. One of these he connected in circuit with a galvanometer, and placed it on the top of the other spiral, through which intermittent currents from a battery were sent at fixed intervals. On making the battery circuit he noticed that the needle of the galvanometer was deflected in one direction, and on breaking the circuit the needle was again deflected but in the opposite direction. Faraday saw in his mind's eye each particle of the circuit through which the current was passing, acting as a centre of force emitting its lines far from it, yet each of these lines returning to its own source; he, in consequence, made a series of experiments by placing various substances in the path of the lines of force to ascertain whether they would in any way be affected or intercepted by the substances so placed. For instance, he found they were sensibly affected by iron, but with copper no satisfactory effects were perceived, although he felt sure that copper did in some way influence them, but so imperceptibly that he was unable to detect it. It was this conviction, and the doubt by Faraday of the result of his experiment with regard to copper which led me to experiment in this direction. My apparatus and its arrangements being somewhat different to Faraday's, I will more fully describe them. Here are two flat spirals of fine silk-covered copper wire, about twelve inches in diameter, suspended, spider web fashion, in separate frames; the two ends of each spiral being attached to terminals at the base of its own frame. These two spirals, which are marked respectively A and B, will now be placed a definite distance apart, and comparatively slow reversals from a battery of ten cells sent through spiral A. You will see the amount of the current induced in B by observing the deflection on the scale of the mirror reflecting galvanometer which is in circuit with that spiral. These inductive effects vary inversely as the square of the distance between the two spirals when parallel to each other; the induced current in B being proportional to the number of reversals of the battery current passing through spiral A, and also to the strength of the current passing. Spiral A is so connected that reversed currents from a battery can be passed through it at any desired speed; B is so connected to the galvanometer and a reverser as to show the deflections caused by the induced currents, which are momentary in duration, and in the galvanometer circuit all on the same side of zero; for, as the battery current on making contact produces an induced current in the reverse direction to itself, but in the same direction when broken, of course the one would neutralise the other, and the galvanometer remain unaffected. To obviate this, the galvanometer connections are reversed with each reversal of the battery current, and thus a steady deflection is produced.

* A lecture delivered at the Royal Institution, June 6th, 1884.

Reversed currents at the speed of 100 per minute will now be passed through spiral A, and you will observe that the induced currents in B give about 28 divisions on the scale of the galvanometer; we will note this on the black board. Now we place this plate of iron midway between the two spirals, and you observe the deflection on the scale is reduced to about one half, or in round numbers 15, showing clearly that the presence of the iron plate is in some way influencing the previous effects. We now remove the iron, when you see the deflection returns to its original amount: 28, and if I replace it by a similar sheet of copper, the interposition does not alter the deflection. The results of this experiment are therefore as follows, viz:—

Speed	... ...	100 reversals per minute.
Induced current	...	28° deflection.
Iron interposed	...	15° „
Copper do.	...	28° „

I may here state that, up to this point, the results of my experiments confirm those of Faraday, that all dielectrics and diamagnetic metals appear in no way to interrupt or interfere with the lines of force.

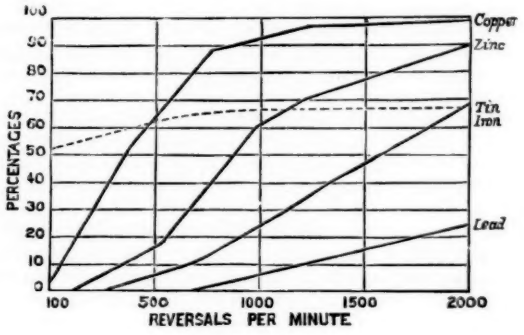


FIG. 1.

Now let us repeat this experiment with the speed of the reversals increased ten times, or to 1,000 per minute; the spirals are in the same position as before, and the deflection is now about 86. I have already said that the current is in direct proportion to the speed of the reversals, the battery and spirals remaining the same. It might therefore cause confusion were I not to explain that the deflection would be ten times as great as it was with the lower speed of reversals, but that the scale of the galvanometer not being sufficiently long to record this high deflection, we have what is termed "shunted" a part of the current. By varying the resistance of the shunt, therefore, the desired amount of current can be sent through the galvanometer. In this case sufficient current passes to keep the beam of light just on the scale at about 86 divisions. We now interpose the sheet of iron as before, and you see the deflection falls again to about one half. We withdraw the iron and the deflection returns to its former amount, 86. We now interpose the copper, when the deflection, instead of remaining stationary, as in the former experiment, actually falls to 17. We now obtain the following results, viz:—

Speed	... ...	1000 reversals per minute.
Induced current	...	86° deflections.
Iron interposed	...	40° „
Copper „	...	17° „

Now the question arose; why does copper, at the low speed of the reversals, apparently have no effect, while at the higher speed it plays so important a part in intercepting the lines of force? The only solution of the phenomenon which suggested itself to me was, that the lines of force have first to polarise the molecules of substances placed in their path before they can pass through them, and in this process time is a very important element to be considered; for instance, at the slow speed there is sufficient time between the reversals for the copper to polarise before the next reversal takes place; whereas at the high speed the copper plate is unable to fully polarise before the next reversal arrives, and then the two induced effects partly blend, and being opposite in direction tend to cancel each other. Now, if this really be the case, the higher the speed the less should be the proportional deflection when experimenting with copper. Careful and reliable measurements have been made, the results of which are shown in fig. 1.

It will be seen, by reference to these results, that the percentage of inductive energy intercepted does not increase for different speeds of the reverser in the same rate with different metals, the increase with iron being very slight, whilst with copper the induced current set up is so long in duration that when the speed of the reverser is at all rapid, the current not having time to exhaust itself before the galvanometer is reversed, tends to produce a lower deflection. If the speed of the reverser is further increased, the induced current is received on the opposite terminal of the galvanometer, and thus a negative result is obtained.

My next object was to verify, if possible, by a different system of experiment, the correctness of this theory, and I could think of no better arrangements than those used by Faraday in some of his experiments on magneto-electric induction. I was not, however, encouraged to proceed in that direction; for, if my theory were correct, the results published by Faraday could not be so; and knowing what a careful experimenter he was I could not doubt but that he was right. After long and careful thought on the subject, I ventured, however, to repeat some of his experiments, and I will again repeat them before you presently.

About sixty years ago Arago made the discovery in electrical science that if a plate of copper be revolved close to a magnetic needle, or magnet suspended in such a way that the latter may rotate in a plane parallel to the former, the magnet tends to follow the motion of the plate; or, if the magnet be revolved, the plate tends to follow its motion. This simple apparatus will better illustrate the experiment. Here is a copper plate one-tenth of an inch thick and seven and half inches in diameter, fixed to a vertical spindle and enclosed in a wooden case having a glass cover; beneath the copper plate is a small grooved pulley around which passes an endless band; the band also passing round this horizontal wheel to which a handle is fixed, so that it may be conveniently revolved. A small brass disc is here provided, in the centre of which is fixed a pointed steel pin, and on this pin is balanced a steel magnet. I will place this on the glass cover over the centre of the copper plate. Now if the copper plate be made to revolve, you will see that the magnet will revolve also, in the direction of the copper disc. There it goes! No doubt you observed how sluggish its movements were at first, and that it was some time before it followed the movement of the disc; this was owing to the attraction of the earth's magnetism on the magnet, which held it in bondage until the speed of the disc was sufficient to overcome its attraction, then, once released, how merrily it appeared to obey the influence of a superior power. The disc now being at rest, the needle has returned into bondage; but if I judiciously use the influence of this magnet to partially neutralise the influence of the earth's attraction, you will observe how much more quickly it obeys the influence of the mysterious power of the revolving disc. There it goes! Apparently more merrily than before.

If the order were reversed and the magnet revolved, the copper disc would act in the same way as the magnet has just done. This is the phenomenon discovered by Arago, who also asserted that the effect takes place, not only with all metals, but with all substances. On this latter point there has always been a difference of opinion between experimenters who have endeavoured to verify Arago's statement. As far as my experiments have gone, I have only obtained reliable results from good conductors of electricity; but I believe that, theoretically, Arago is right; for, as all substances are, in a certain degree, conductors of electricity, it, I think, necessarily follows that we only

want sufficiently sensitive instruments to develop the phenomenon, as Arago asserts, in every substance. It has been stated that all substances when subjected to a sufficiently strong magnetic force are found to give indications of polarity, and also, when magnetic force acts on any medium, whether magnetic, diamagnetic or neutral, it produces within it a phenomenon called magneto-induction. If this be the case, it materially strengthens the correctness of Arago's assertion.

(*To be continued.*)

ON THE CAUSES OF DISTURBANCE IN TELEPHONIC COMMUNICATIONS.

ACCORDING to the observations made by M. D'Arsonval, it appears that the nerve of the frog, which has always been regarded as the most perfect of all galvanoscopes, is 200 times less sensitive than the telephone. But the experiment of M. De Moget proved that the amplitude of vibration of the plate of the transmitter is 1,800 times greater than that of the corresponding receiver, and without considering the losses sustained upon the line, we must attribute a considerable portion of the results obtained in telephony to the perfection of the organ of hearing.

Whatever may be the cause of this extreme sensitiveness, it exists nevertheless, and must be taken into consideration if we wish to eliminate the disturbing effects which disguise or diminish the power of the voice.

The causes of these disturbing actions exist, either at the transmitting station, on the line, or at the receiving station, but very often at all three of them at the same time, so that an analysis of the special conditions in each case, says Mr. E. Van Hoey, in *L'Ingénieur Conseil*, becomes absolutely necessary.

Taking into account only the essential parts, a microtelephonic station comprises a microphone transmitter with battery, a call bell with or without battery and a telephone receiver, and a purely telephonic station ; a call bell with battery and a telephone serving at once as transmitter and as receiver.

Most generally, all this apparatus is assembled upon one board, which is fixed to one of the walls of a room where the speech is transmitted and received.

So long as we have a purely telephonic communication, this mode of grouping all the elements of a station has no disadvantages ; but when this arrangement is used for a microtelephonic station, inconveniences may result in certain cases, as we shall see directly.

The battery most generally used for telephony is the Leclanché, with porous cell. It is composed, as we know, of a glass jar containing a solution of chlorhydrate of ammonia ; in this is immersed a porous vessel which contains a mixture of carbon and peroxide of manganese, surrounding a plate of carbon. This latter forms the positive pole of the battery, the negative pole being a zinc rod immersed in the solution of chlorhydrate

Without describing accurately all the reactions which take place during the passage of the current, we may say that there is, on one hand, a formation of oxychloride of zinc, and on the other, the reduction of the peroxide of manganese with disengagement of ammoniacal gas. From this we may conclude that in putting into the battery sufficient water to ensure its working properly, we must avoid inundating the mixture contained in the porous cell ; for a too strong imbibition of the carbon and peroxide of manganese would result in preventing the disengagement of ammoniacal gas and producing polarisation of the element.

In this case the battery would not work as well, the current strength would be lower, and consequently the speech in the receiving apparatus would not be as loud. We think that it is best to have the liquid in the glass vessel one-half of the height of the porous cell.

This precaution does not seem to be taken generally if we consider the rather numerous cases of batteries in which the porous cell is too much submerged, although, for several reasons, it should be specially attended to in installations of this kind.

If we now examine the phenomena which occur in a battery in the normal state of construction and mounting, and which is placed in a position where the temperature is more or less high, we shall soon see that crystals are deposited at once upon the glass vessel, upon the porous cell, and upon the zinc rod.

Following this examination more attentively, we observe that these crystals are not of the same nature, and whilst the first are formed of chlorhydrate of ammonia, chloride of zinc enters into the composition of the second

The following experiment, which may be made for this purpose, completely proves the difference of substance of the crystals which are deposited upon the vessel and upon the zinc.

Having thrown chlorhydrate of ammonia into a glass vessel containing water up to one-third of its height, and placed in a room having a mean temperature of about 15° C., we may observe, at the end of the third or fourth day, the presence of a light deposit of salt forming a band above the surface of the liquid. This band increases continually in width, and after about a month reaches the top of the vessel, and then redescends in a progressive manner upon the outside of the receptacle, and reaches the bottom in about two months and a-half.

Whilst the band is developing thus daily, the deposit of salt which forms it, and which appears at first like a sort of dew, offers successively more abundant and more regular crystals, which constitute the creeping salts.

They creep, in fact, actually along the surfaces of the cells, and as soon as a slight layer is produced by the evaporation of a portion of the liquid, this, drawn up by capillary attraction between the walls and the small crystals already formed, strengthens and regulates them.

If, after having proceeded in this manner, we continue the experiment by immersing a rod of zinc in the solution of chlorhydrate, we perceive no change in the phenomena, which remain as they were. No chemical action is manifested by any change whatever of the creeping salts, nor are any crystals deposited upon the zinc rod.

It results from these facts that the crystallisations which we observe upon the vessels are different from those upon the zinc, and that the first, which are produced in a liquid containing only chloride of ammonium, can only be formed from this salt.

Those, on the contrary, which cover the zinc, and which only exist in batteries which have already worked, are formed of the chloride of this metal, as M. Wurtz said, in his dictionary of chemistry.

This last point may, moreover, be explained as follows :—

The chloride of zinc which is produced under the action of the electric current requires, in order to be dissolved easily, a liquid containing chlorine, and as soon as this becomes deficient it is deposited in the form of crystals falling to the bottom of the receptacle. The formation of the creeping salt, which impoverishes the chloruretted liquid intended to dissolve the salt of zinc, is therefore the cause of the deposit of crystals from it.

Therefore, in order to have a good reproduction of the speech, we know that it is important that the battery be in special conditions, which, although not completely preventing the formation of the creeping salt, nevertheless retards it.

The presence of these salts, in fact, leads directly to a diminution in the quantity of active liquid, and causes during the working of the battery the formation of crystals upon the zinc, which prevent it from being attacked, and increase the resistance of the element.

We have seen that a certain degree of heat sensibly favours the production of crystals of chloride of ammonium upon the vessels, and that the condition necessary for retarding this as much as possible is

placing the battery in a place where the temperature is low. It follows, therefore, that by grouping upon the same board all the apparatus of a microtelephonic station, including the battery, the desideratum mentioned above cannot be realised under all circumstances.

No more need be said on the subject of disturbances caused by the special conditions of the battery.

We will now study the microphone transmitter, which forms the second apparatus of a microtelephonic station.

The most important element which enters into its composition is certainly the carbon, of which the nature and condition exercise a very great influence upon the loudness and clearness of the speech.

It must not be powdery, for instance, for by the vibrations, which are, so to speak, continual, to which the apparatus is subjected, the molecules of carbon are accumulated between the contacts and produce a disagreeable crackling which accompanies the voice.

Other organic powders (dry, like the first) produce, moreover, the same effect, and like them may be momentarily dislodged by a few sharp blows given by the person speaking upon the box of the transmitter where these derangements appear.

Very often M. Carré's electric light carbons are used. These are prepared by pulverising, compressing, and subjecting to a high temperature in crucibles a mixture of very pure coke in fine powder, calcined lamp black, and syrup of sugar.

On examining with a lens a carbon thus prepared, we find a certain number of small white points apparently formed of crystals of sugar not completely carbonised. They exist tolerably regularly in the entire mass of carbon, and impregnate the surface with a slight dampness, which by their nature they extract from the surrounding air. This effect is soon followed by the disintegration of the carbon and the formation of a humid powder, which is very hard to detach from the contacts. We may, however, do this by passing a strip of very clean paper over them.

In order not to be obliged to do this too often, it is desirable to remove the cause of the formation of this sort of powder, by removing every trace of the white points by perfectly polishing the surface of the carbon, so as to give it the appearance of a metallic body.

There remains now only a very little to be said about the bell, the line, and the telephone, which form the last parts to be examined.

As regards the bell, we may clearly state that the preference should be given to the magnetic bell; that is to say, that working without a battery, because of the numerous advantages which it possesses, amongst others, the ensuring of better contact. This removes one cause of weakness of voice which occurs rather frequently in apparatus where this contact is only made in an imperfect manner.

The line is sometimes also the seat of disturbances, especially when it has a rusty or badly soldered joint, for then the resistance of the circuit increases, and the intensity of the current is consequently diminished.

It may happen, also, that the wire touches a conductor in communication with the earth; another line, for instance. In this case, the leakage thus accidentally introduced diminishes the resistance of the circuit and increases the total current strength which is divided at the point of contact in inverse proportion to the resistances of the paths open to it. Consequently, the current which actuates the telephone receiver is always weaker than when the line is in the regular condition, that is to say, when there are no abnormal leakages.

A similar weakening of the current may result from the bad insulation of the line upon the poles, as well as from the employment of a bad communication with earth.

As regards the telephone, we may say that the only defect which it can present is an undulation which the vibrating plate takes when the apparatus is kept in a damp place, or when it serves as a transmitter. In these conditions, in fact, the aqueous vapour is condensed upon the plate, and attacks the metal with whatever varnish it may be covered. At the point where rust is formed, that is to say, at the centre which is most exposed to dampness, the plate is no longer in its normal condition, and owing to the combined action of this dampness and the attractive force, it takes a concave curvature towards the middle of the apparatus.

This modification sometimes causes the plate to stick to the magnet, and prevents all speech. It is necessary in this case to heat the apparatus, the plate then resumes its original form. Sometimes the defect is not as pronounced, but it has always enough influence to alter the tone of the apparatus.

Thus are expressed broadly the causes which produce a weakening of the voice in telephonic communications, and the means of preventing or lessening them.

REVIEW.

A Pocket-book of Electrical Rules and Tables for the use of Electricians and Engineers. By JOHN MUNRO and ANDREW JAMIESON. London: Charles Griffin & Company, 12, Exeter Street, Strand.

Although but a few weeks have elapsed since this pocket-book was published, a second edition has been called for; this sufficiently proves the demand which exists for a work of the kind. Much of the success which attends a scientific book depends upon the ability and practical knowledge of the author or authors, and in the present instance success has been almost a matter of course, for the compilation could hardly have been undertaken by men more qualified for the task than Messrs. Munro and Jamieson. The mass of matter which has been collected, and judiciously condensed, is very great, and, from the thinness of the paper this has been printed on, we have over 480 pages without producing a bulky volume; the work, in fact, is uniform in size with Molesworth's well-known pocket-book of engineering formulæ. The general contents are as follows:—"Units of Measurement," "Measures," "Testing," "Conductors," "Dielectrics," "Submarine Cables," "Telegraphy," "Electro-chemistry and Metallurgy," "Batteries," "Dynamos and Motors," "Electric Lighting," "Miscellaneous," "Logarithms." From this list it will be seen that the ground covered is very wide, and that consequently much discretion had to be exercised so as to give information which was actually of value in each branch of the profession considered. Although, no doubt, there may be much which critics would find fanlt with, yet we must confess that, taking the work as a whole, the latter has been carried out in a manner which does the greatest credit to the authors. The free use of black type headings greatly facilitates references, a point which is deserving of notice. The book may be described as a modern edition of "Clark and Sabine's Electrical Tables and Formulæ" put into a pocket-book form, and it will, we believe, be soon as well known and as much used as the earlier work has been. There is always a great temptation in authors to insert matter in their pages which is actually of but little practical value, but in Messrs. Munro and Jamieson's production we find little to complain of on this score. A contemporary, however, remarks:—

"The compilers might well consider the real value of the table on pp. 214, *et seq.* Is it, in fact, of any practical value whatever? The answer to such a question may, perhaps, be given by an appeal to the writings of Forbes, Gordon, Blakesley and others." The authors will, no doubt, feel grateful for their attention being drawn to any errors or useless matter, but in this particular instance, we fancy, they are not to blame, for the writings on the subject in question of the above-mentioned gentlemen were certainly not in print when they compiled this portion of their book; besides which, had the writer of these remarks taken the trouble to read the preliminary data to the tables

referred to, he would have found (see pp. 212, 213) that Mr. Robert Sabine, C.E., had fully investigated the case of bare bright copper conductors. The interesting point about it is this, that Forbes should have brought before the Society of Telegraph Engineers on March 27th, 1884, the precise formula as stated by Sabine first in the ELECTRICAL REVIEW* for March 3rd, 1883, p. 186, without the slightest acknowledgement. Sabine's formula (see Munro and Jamieson, p. 213) is :

$$d = \sqrt[3]{\frac{4\,\mathfrak{c}}{\mathrm{J}\,h\,\pi^2} \cdot \frac{c^2}{\Delta\,t}}$$

whence $$c^2 = d^3 \Delta\, t \frac{\pi^2\, h}{4\,\mathfrak{c} \times 0{\cdot}24}$$

Forbes's gives $$\mathrm{C}^2 = \mathrm{D}^3\, t \,.\, \frac{\pi^2\, \mathrm{E}}{4\,\mathrm{R} \times 0{\cdot}24}$$

See "Munro and Jamieson," p. 426, and *Journal, Society of Telegraph Engineers*, Vol. XIII., p. 239, at foot.

Where in each formula respectively

c and C = current strength in ampères,
d and D = diameter of wire in centimetres,
Δt and t = excess of temperature cent. of wire above that of its surroundings,
h and E = the heat radiated per second from. a square centimetre surface per degree of temperature difference or the coefficient of radiation and convection,
$\mathfrak{c}$ and R = specific electrical resistance of conductor,
0·24 = number of units of heat in 1 Joule.

In other words, Forbes has simply changed the letters in Sabine's formula and, in certain instances, with no advantage. For example, it is usual among practical electricians to use the letter E to indicate electromotive force, especially when C stands on the opposite side of an equation to E and R, although in this instance there is no electromotive force in question.

Referring again to the "electric light lead" tables on pages 214—216, we observe a foot note, "When the conductor is covered with India rubber, the rise of temperature will be about 25 per cent. *less than* the values indicated above" (viz. for bright copper). We know that Mr. Sabine worked this matter out very fully and expressed his views on the subject in 1882, yet we find Forbes in 1884 saying (on p. 261, at foot, *Soc. Tel. Eng.'s. Journal*, Vol. XIII.) :—

"1. One of the most important results *I* have obtained is, that the insulation of an ærial conductor is favourable and gives us a power of using larger currents with conductors of the same size when the diameters are not very great"! Forbes has simply combined Fourier's well-known formula with that of Sabine and come to the same result as the latter, without giving him any credit. We do not wish to discredit the work of Prof. Forbes, only we think it advisable to point out that "Breguets" are alive who recognise the work of their friends even when dished up afresh by the skilled hand of a professor.

The use of different letters or symbols by different authorities, or even by the same authority, to express the same quantities is very common, and although we are inclined to think that the inconvenience of this practice is more apparent than real, yet any attempt to avoid it is commendable, and therefore the use in this pocket-book of the same letters throughout (except when quoting *verbatim* somebody's formula), is deserving of notice.

Considering the sterling value of Messrs. Munro and Jamieson's pocket-book it would seem deserving of a somewhat lengthy review, but the nature of the work does not admit of this. In conclusion we must congratulate the authors on the success which they have already obtained—a success which is well deserved.

* See also ELECTRICAL REVIEW for Jan. 6th, March 31st, and May 5th, 1883.

THE ORGANISATION OF THE POST AND TELEGRAPH SERVICE IN FRANCE.

The Journal Officiel de la République Française of the 19th ult. contains a very interesting report on the organisation of the post and telegraph service before and since the year 1878, addressed to the President of the French Republic, by M. Cochery, Minister of Posts and Telegraphs.

In the beginning of this report the minister says, that, considering the numerous modifications which have taken place in the post and telegraph services since they became united in the beginning of 1878, it would appear to him that the time had come to render an account of the measures which have been adopted, of the reforms which have been introduced, and of the results thus obtained, and to reply in this manner to the wishes many times expressed by the financial committees of the Parliament.

The decree authorising the fusion of the post and telegraph services was signed on the 27th February, 1878, as proposed by M. Léon Say, who was then Minister of Finance, and on the 1st May following considerable reductions were made in the internal telegraph and postal rates.

The report then goes on by describing the state of affairs of both branches before the fusion, and also mentions what had been done in that direction in other countries, more especially in England, Germany and Belgium. Under the heading, "Improvements in the Situations of the Staff," we notice that the economies realised by the fusion were immediately devoted to increase the salaries of the staff, according to their rank. It was considered at the time when considerably more work was required from the employés, that it was no more than just to improve their position and to assure them a better future, and more especially to try to do away with the evident inequalities that existed in their salaries and those of the employés of other public services.

After mentioning the duties, salaries, &c., of messengers, clerks, superintendents, inspectors, directors and the organisation of the central administration in Paris, we come to a description of the High School of Telegraphy and the various classes which have been opened in different towns. We notice therein that several foreigners have already been sent by the Governments of different countries to follow the courses at the High School of Telegraphy, and that their presence there may be taken as a proof that the institution of that school has been the object of universal approbation.

The teaching of foreign languages has been organised at several important central stations. English is taught at Bordeaux, Brest, Havre, Lille, Rennes, Nice and Marseilles; German at Lyons and Nancy; Spanish at Toulouse; Italian at Marseilles and Toulouse. To encourage this study of foreign languages a monthly allowance of 20 francs is given to those employés who have successfully passed an examination and whose knowledge of a foreign language is made use of in the service.

The library at the Ministry, which in 1877 did not consist of 900 volumes, now possesses more than 7,000 volumes, and a large number of interesting documents. It has been arranged in such a way as to facilitate the studies of, and to be consulted by, those employés to whom it is open, even on Sundays and during the evening.

The French Administration possesses a number of old instruments, &c., which at the Electrical Exhibition were of a real retrospective interest, and contributed largely to the success of the special exhibition of the French Administration. In order that this curious collection, which contains all the different apparatus made since the introduction of the telegraph, may always be consulted with advantage, it is now exhibited in a large room, and it is the intention of the Administration to continue in completing and extending it.

Space does not allow us to speak of all the improvements that have been introduced in the postal services, and especially in the mail services, with the French colonies, which are very fully described in the report. We come now to what the report says on the system of telegraphs and apparatus :—

"The absence of direct communications either between certain important towns and Paris, or between towns, the interests of which required a frequent use of the telegraph, and the insufficiency of those which did exist, were as many causes of delay in the transmissions. We set to work to put an end to this by a quick extension of our internal telegraph system.

"Fourteen international lines have in the meantime been established; a direct communication has been opened between Paris and Constantinople; but the resources of the Administration have been devoted more particularly to extend and to improve our internal communications."

From the 1st January, 1878, till the 1st January, 1884, 509 new lines have been opened to the service, viz. :—

14 international lines.
28 first-class lines, connecting principal central stations.
119 second-class lines, of which 51 end in Paris.
158 inter-departmental or auxiliary lines.
190 departmental lines.

A large number of towns, which during the old system could not communicate direct with Paris, have now been placed in direct communication with that town, and at present only 10 principal towns of departments are still without it.

The total length of the telegraph lines, which in 1877 was 55,000 kilometres, amounted to 73,000 kilometres on the 31st December, 1883, or an annual increase of 5 per cent.

The growth in length of the wires has been even more extensive during the last six years.

It has been brought from 145,000 kilometres to 224,000 kilometres, or a total increase of 79,000 kilometres, equal to 9 per cent. per year during that time; whilst from 1871 to 1877 the average annual increase did not exceed 3,656 kilometres, or 3·06 per cent.

The underground wires are not included in these totals. This special system, which on the 31st December, 1877, was composed of 4,150 kilometres of wires, consists at present of 14,000 kilometres of wires, or a total increase of 9,850 kilometres since the 1st January, 1878.

The private wires, which amount to 7,500 kilometres, and the telegraph system of the railways, with a length of 78,000 kilometres of wires, are not included in these ciphers.

As the manner in which telegraph lines are constructed in France gives sufficient guarantees for strength and insulation, it has not been found necessary to introduce any remarkable modifications in the operations of erecting them.

Submarine communications have not been neglected. Six important cables have been laid since 1878.

Corsica was connected with France for the first time in 1861, but that cable broke the following year.

We found ourselves since that time tributaries to Italy, which charged a transit rate, calculated in the beginning at the rate of 1·50 francs and at 1 franc, since 1865, for every message of twenty words. This transit caused the French Treasury an annual expenditure of about 40,000 francs.

Since the lowering of the telegraph rates, a message from one to ten words to Corsica, which did cost only 50 centimes, had to pay a transit price of 1 franc to the benefit of Italy, or a loss of 50 centimes to the treasury.

It was therefore urgently required to put a stop to this abnormal state of affairs by the laying of a direct cable.

This work was adjudicated on the 28th May, 1878, and on the 16th November following, *i.e.*, five months and a-half later, the new cable was opened to the telegraph service. The length of this cable is 281,504 metres. The landing points are near Antibes and in the Bay of St. Florent (Corsica), but direct communication has thereby been established between Nice and Bastia.

An agreement has been made with Italy, since the opening of this cable, for the free transmission over the Franco-Italian cables of all messages between France and Corsica, in case of interruption of this cable.

This arrangement, which by reciprocity has been conceded, for all messages sent *viâ* Corsica from Italy to Sardinia, is very advantageous.

(To be continued.)

THE POST OFFICE AND THE TELEPHONE COMPANIES.

THE telephone companies in this country are now engaged in a struggle with the Post Office, upon the result of which their very existence would seem in a great measure to depend. The action of the department in the matter is a little difficult to understand, for upon the face of it it seems little else than a deliberate attempt to wreck each and every one of those companies which have established themselves within the last five years for the purpose of promoting the use of the telephone in the United Kingdom. It is asserted upon the part of the Post Office that its desire is to protect the public from the misuse of a monopoly; but the infliction of requirements, some absolutely impossible to be complied with, and others likely to produce no effect beyond the limitation of telephonic facilities to insignificant proportions, savours more of an attempt at total suppression than the proper regulation of a monopoly. When such pretensions are made, one naturally tries to discover wherein lies the benefit to the public from the imposition of such stringent regulations. But the closest examination in this instance reveals nothing more than the promise of most direct disadvantages to the community if the present course be persisted in.

Having acquired the right to control the application of the telephone to the public service by means of a purely technical decision, given upon the wording of an Act framed and passed years before the telephone was invented, and admittedly when there was no anticipation of such an invention, the Post Office granted licenses to various telephone companies, the main condition being the payment to the department of a royalty of 10 per cent. upon the gross receipts. This plan worked with some success for a time, and the progress of the telephone was sure, if slow; but about two years ago the Postmaster-General announced a complete change of policy, insisting that there should be in every new license a condition that the company should undertake to sell to him as many instruments as he thought fit to demand. The United Telephone Company, which had purchased the absolute proprietorship for the United Kingdom of the patents of Bell, Edison, and Blake, had, at the time this new condition was imposed, established a number of subsidiary companies to work certain localities in various parts of the kingdom, and the concessions to these companies secured them the exclusive right to use the patent instruments of the United Company within their respective districts; but the right of use only, and not of sale. Thus, for them to sell to the Postmaster-General instruments which are not their own property, is an evident impossibility. The stipulation required is such, that even the United Company themselves, who alone have the right to sell any of the instruments, are not likely to comply with it; for it is required that upon the sale taking place the Postmaster-General shall be freed from all restrictions as to the use to which the instruments may be put. Indeed, it is doubtful if the United Company have power to assent to such a condition, for by the terms of their agreements with the subsidiary companies, they contract not to sell, or permit to be used, any instruments over which they exercise control in any part of the districts worked by those companies. It is obvious that the disposal of instruments in the manner insisted upon by the Postmaster-General, absolutely free from all restrictions, would have a most injurious effect upon the prospects of the companies, for they would thereby deprive themselves of the exclusive rights which they have purchased at no inconsiderable cost, and upon which their shares have been subscribed for.

Mr. Fawcett, in a letter to Mr. Gray, M.P., asserted that he deemed the condition alluded to essential for the protection of the department. It is perfectly easy to suppose that at first a fear may have existed that the new means of speedy communication would affect the use of the telegraph; indeed, it was such a fear which led to the efforts of the Post Office in 1878 to insert in the Supplementary Telegraph Bill of that year a clause which should clearly include the telephone in the meaning of the bill, and, those efforts having failed, to the proceedings for an injunction against the telephone company, which ultimately led to the placing of the telephone under State control. The friends of the new system, however, contended strenuously that it was not calculated to prejudicially affect the older means of electric communication, but rather to further the use of it in many ways. From the statistics before us it would seem that this contention has been amply proved, for, notwithstanding the considerable number of telephone exchanges already existing, the number of telegraphic messages sent last year showed an increase of over 600,000. Therefore, Mr. Fawcett's expressed desire for the protection of the revenue of his department seems to run counter to his actual policy, which has a positive tendency to prevent the use of the telephone as far as the facilities afforded by private enterprise are concerned, and thereby to inflict injury upon the telegraph service by limiting the methods by which it may be called into play. The allegation that it is in the interests of the public that the Postmaster-General seeks to secure the control of as many telephonic instruments as possible is perfectly idle. By its own acknowledgment, the department is in possession of over 5,000 instruments, acquired by more than doubtful means, at the same time having the right to obtain from the United Company a further number of 15,000: yet to all the telephone exchanges established by the Post Office there were only 748 subscribers on the 31st March last. The operations of the telephone companies and their endeavours to extend the possibilities of the telephone system are much more in consonance with public convenience than the contrary action pursued by the Post Office authorities. One method of greatly increasing the utility of the system would have been to construct trunk wires from town to town, and the connection of local exchanges with these trunk wires. When the United Company attempted to obtain

the right to establish such a method of communication between towns, they were met with a direct refusal; the Post Office claimed the exclusive right to erect, work, and maintain trunk wires, and stipulated for a charge of £10 per mile per annum for their use, taking, in addition, half the surplus gross revenue of the companies after that payment. Such a scale of charges seems almost prohibitive, but, trusting to the increased advantages subscribers would gain for remuneration, the United Company acceded to it, until, in April last year, a further condition was insisted upon—that each subscriber using the trunk communication should be compelled to make an annual payment of 10s. per mile. One company alone is attempting to do business under these conditions, which are obviously calculated to restrict the subscriptions to the exchanges and to the trunk wires very considerably. Another respect in which public advantage would be better consulted by assent than by the present arbitrary course is in the matter of the proposed establishment of "call-rooms," where any member of the public, whether a subscriber or not, could, for a small payment, converse directly with any subscriber to the exchange. An inestimable benefit would be conferred upon the community by this means without the least detriment to the telegraph service; for the telephone, in such cases, would be most generally used for the transmission of messages which would not be deemed sufficiently important to send by telegraph, but which would yet save time and possible inconvenience. Permission to open such call-rooms was applied for, and peremptorily refused by the Post Office.

The grievances of the telephone companies are not nearly all stated above: they have much reason to complain of the unfair preference in many respects extended to the subscribers to the telephone exchanges belonging to the department. One of the advantages given by the Post Office is that they permit their subscribers to speak a telegram through the telephone to the central Post Office and have it there taken down by a clerk and transmitted, and also to have telegrams communicated to them by telephone instead of being conveyed in the ordinary manner. Here is a fruitful source of additional business, and consequently an increase of revenue, quite setting aside the old contention of rivalry between the two systems; yet, in a most illogical manner, the Postmaster-General imposes a charge upon the telephone companies for a similar convenience of £5 5s. for each subscriber. And this is protecting the revenue of the department and acting in the interests of the public! The remarks made by the Postmaster-General two years ago are worth remembering in this connection. He then declared in favour of free competition, and said that when that competition had gone on for some time the Government would be able to judge who did the telephone business best; if it were done by the private companies better than by the Post Office, the department would be delighted to have the whole telephone business of the country conducted by private enterprise. The nature of the "free competition" permitted, consisting, as it does, of a series of restrictions, conditions, and impediments, suggestive of anything rather than of fair-play, has already been shown.

We can only assume that the Postmaster-General has been hitherto proceeding upon a mistaken notion of the effect likely to be produced by the progress of telephonic communication; no one for a moment will question the sincerity of his motives, his desire for the most remunerative administration of his department combined with the greatest possible advantages to the public. But the regrettable necessity for his dependence upon others in regard to many matters of detail renders it difficult for him to obtain such a complete mental mastery of the whole situation as it is desirable he should possess. Facts, however, are obstinate and hard to be suppressed. Already signs are apparent that he is becoming more and more alive to the justice of the claims set forward by the companies, and we may hope that, as a result of the conference which he himself has suggested, a new era for telephonic enterprise will open out, with the abandonment by the Post Office of those tyrannical conditions it has, in its arbitrary mood, thought fit to impose. Then, with more regard for efficient service and the convenience of subscribers than the telephone companies themselves at present display, there will be some reason to indulge in the hope that Great Britain will not long labour under the stigma of being the most backward of all civilised nations (where the telephone has been introduced) in applying it to the public service.

NOTES.

Electric Lighting.—The Jablochkoff electric candle, the pioneer of all arc lighting on a practical scale has ceased, after a period of more than five and a-half years, to illuminate the Thames Embankment by reason of the termination of the contract with the Metropolitan Board of Works. The lights were put up in 1878 for a three months trial, consequently the works were not of a permanent character, yet the lights, with the exception of a few occasional mishaps, have given general satisfaction. No more exposed position could have been selected for such a trial, and the successful working of the system under the circumstances, still further proves its value. It is an open secret that the price (1½d. per hour per lamp) paid for the lights resulted in a considerable loss to the company. From the recent address of Sir J. Bazalgette at the opening meeting of the Institution of Civil Engineers this season, it appears that twice the illuminating power is obtained on the Embankment from the Jablochkoff lights which could have been obtained from gas if the same money were expended; in other words the price should have been 3d. per hour as compared with the same light from gas. Notwithstanding the disappearance of "Jablochkoff" from the river side we still hope that better days are in store for this very effective and most simple of all arc systems.

The P. and O. steamer *Tasmania*, the latest addition to the P. and O. Company's fleet, has just made her trial trip at Greenock, an average speed of 15½ knots being obtained. This vessel is 400 ft. long, has 45 ft. beam, and is 31½ ft. deep, the gross tonnage being 4,500 tons, and the horse-power 4,000 effective. The *Tasmania*, which has been built and engined by Messrs. Caird and Co., of Greenock, is of steel, and has been fitted with the electric light by Messrs. Siemens Brothers. This firm has arranged the overhead lights of the saloon in a somewhat novel way, no brackets or pendants being used, the lights being inserted in cut-glass pillars attached to the deck, thus leaving all the headroom clear for that Eastern necessity, the punkah. The vessel will carry about 200 passengers and 3,800 tons of cargo, and will leave London on the 16th inst. in connection with the India, China, and Australian mail services.

The experiments in street lighting at Wimbledon, which have now extended over three months, were brought to a close last week. They have been devoted principally to the solution of two points, namely, the cost of production and the best mode of distributing the incandescent electric light along the streets. Taking as a unit the light of 10 candles—or the average effective illumination given by five cubic feet of gas in a street lamp—the cost comes out approximately ¼d. per lamp per hour for electric lighting. The most efficient practical mode of distributing light for a main street like that at Wimbledon appears to be a 50-candle lamp fixed 20 feet high above the centre of the road at intervals of 100 feet apart. Innumerable modes of reflecting light have been tried; but, according to the opinion of competent judges, the best effects have been produced by a polished nickel-plated iron surface of a slightly convex form, and by a dioptric system devised by Mr. Trotter. An important deputation of the City

Commissioners of Sewers, including the chairman, Mr. Innes, and the chairman of the Streets Committee, Mr. Altman, visited Wimbledon recently, and witnessed several interesting experiments. Mr. W. H. Preece, to whom the public are mainly indebted for this prolonged test of electricity for street illumination, received them at his house, which is illuminated by electricity, and then conducted them through the village to the lighting station. Electric lighting by these experiments, says the *Building and Engineering Times*, has certainly been carried forward a stage, and what ought to follow the lighting up of Wimbledon and the visits there of men of science and City magnates during the last three months, is a thorough application of the systems to some of our London thoroughfares, set apart temporarily for the purpose.

On Friday evening last week some 200 gentlemen accepted invitations to a *conversazione* given at the residence of Sir Daniel Cooper, De Vere Gardens, Kensington. The dining and drawing-rooms, the library, the reception and other rooms, as well as the hall and corridors, were lighted by Swan lamps of 20 candle-power each, and their effect was certainly most bright and charming. The current was supplied from Faure-Sellon-Volckmar accumulators of the newest type, placed in the coach-house. In the library and one of the reception-rooms were placed a variety of electrical apparatus, and amongst the interesting objects exhibited was a model of Reckenzaun's electrical tramcar, fitted with small accumulators, which ran up and down a pair of rails, switching itself backwards and forwards at each end of the line. Several of Mr. Reckenzaun's electro-motors were also exhibited. Mr. Sellon, of secondary battery fame, exhibited his electrical system of warming and ventilating rooms. The electric lighting was arranged by the Electrical Power Storage Company, and the accumulators were charged at the company's works and sent to Sir Daniel Cooper's residence the day before; they were calculated to be equal to meeting the demands upon them for 10 hours. We are not sure whether the installation was intended as a demonstration of general *domestic* electric lighting; we scarcely think so. Although in the early days of accumulators we were promised a house-to-house supply of stored electrical energy, delivered each day by carrier, it does not appear that this method of doing business has made any headway, neither is this to be expected except on such special occasions as that referred to above. It is generally believed that accumulators must be employed to secure the success of any large installation of house-to-house lighting, and naturally these unwieldy apparatus will have special stations for their permanent reception, as at Colchester. It appears to us that one of the most likely forms of secondary battery for lengthened practical work is that of Mr. Sellon. This seems to be more than usually good from a mechanical point of view, and not likely to fail from the buckling of its plates or from short-circuiting. But the success or failure of accumulators depends upon their applicability to supply the wants of the general public, and the good working of an installation in private houses, the owners of which have a more or less extensive knowledge of electrical science, cannot be said to prove more than that accumulators may be successfully employed by a careful supervision over, and technical knowledge of, their operations.

The gigantic statue of Liberty, just presented to America by the French people, is to stand on Bedloe's Island, at the entrance to the Bay of New York, and is to bear in its hand a torch lit by electricity, which is to symbolise "Liberty enlightening the world."

Last week the largest vessel ever built at Dumbarton was launched for the Shaw, Saville, and Albion Company, Limited, of London. The *Arawa* is designed for this company's London and New Zealand line, and will be lighted throughout by 300 electric lamps. A sister vessel, the *Tainui* is in course of construction, and will be similarly lighted.

Telephony.—With reference to the statement that the National Telephone Company has given up the trunk line to Glasgow, we learn that a new lease for two years has been entered upon.

The Post Office and the Telephone.—Mr. Houldsworth asked the Postmaster-General, in the House of Commons on Thursday evening, the 26th ult., whether he was aware that Press news is supplied to the Ellesmere, Russell, Central, and thirteen other clubs in Manchester; whether the department had power under the Act of Parliament to restrain the members of the said clubs from using telephonic communication for their own private business and affairs between these clubs; and whether he was prepared to withdraw the interdict issued by the department so far as applies to telephonic communication between clubs simultaneously supplied with the Press news. Mr. Fawcett stated that he was aware that Press news is supplied to the clubs mentioned, as well as others in Manchester. The question of the legality of telephonic communication between separate clubs was quite distinct from that of the conditions regulating the supply of Press news. He had already indicated what the latter conditions were, and it would be inconvenient to enter upon a discussion of the legal position of the Post Office with regard to telephonic communication in reply to a question.

Mr. O'Shea asked the Postmaster General, on Monday evening, whether in deciding on any suggestions which, in accordance with his invitation, might be laid before him by telephone companies, he would take care to exact such conditions as might protect the public against the evil effect of private monopolies which might be created by the amalgamation of, or by arrangements between, the companies. Mr. Fawcett: I can assure my hon. friend that the considerations to which he refers will be carefully taken into account in dealing with the question of telephonic communication.

The *Manchester Guardian* of the 30th ult., in an article upon this subject, said:—"It is always desirable that the powers of the State should be too ample rather than not ample enough in relation to questions of monopoly. This does not imply that the State should, in all cases, exercise its full privileges; that depends entirely upon whether such exercise is consistent with the interests of the public or not. But it is not for the department to settle how far it will be expedient to assert its legal rights. The heads of the Government Departments are bound to take a strictly business view of their duties, and to defend the special interests of their departments. It is for Parliament itself to decide when such defence is no longer needed. . . . . As regards the possibility of ultimate purchase by the department of the telephone business, it cannot be desirable that the present generation should be restricted from the use of the telephone in order that a subsequent generation may acquire a going business cheaply. The idea is self-contradictory, for if the private systems are not allowed to develop there will be no business for the State to purchase. . . . To endeavour to restrict monopolies is, of course, proper enough; but the particular measures hitherto adopted by the Post Office in the present instance are not of a kind which can be seriously defended; and if the object is to be attained, it must be by means which shall not be inconsistent with the full development of the system, and with the full and immediate advantages which the public may claim to derive from it. If the companies abuse their position by overcharging, there will always be the telegraph to fall back upon; but if the monopolies are to be checked by insisting upon the companies charging for their services as much as it costs to telegraph, then the cure is as bad as the evil. . . . . State management, if it should ever be desirable, would be more readily applied at a later stage, and the object of the Government should be rather to provide for the ultimate acquisition of telephone property than to restrict its immediate development. A maximum tariff, maximum dividends, the

right of supervision, and the power of ultimate purchase may all properly be reserved; but in the meanwhile the public should receive the full advantage of the wonderful invention which science has now placed at its service."

The Telephone and Fire.—As showing the advantages of the telephone in cases of fire, it may be mentioned that the news of the recent outbreak at the Theatre Royal, Edinburgh, was received by its means at the Central Fire Station within a few minutes of the first alarm.

Fall of a Telephone Wire.—The fall of a telephone wire is of rare occurrence, and it is fortunate that it is so, if we may take the following as an indication of what is likely to happen in all such cases. A wire, connecting the North Staffordshire Infirmary with the surgeries of the various surgeons of the district, at Hanley, recently broke, knocking down the chimney of a house to which it was attached; the chimney and the broken wire falling on the roof of a kitchen, demolished it, and the wire, rebounding and curling up in the street, caught a child five years old, lifted her in the air some distance, and dashed her to the ground, rendering her insensible and injuring one of her legs severely.

Rating of Telephone Wires.—An important decision upon this question was given in the Court of Queen's Bench by Mr. Justice Mathew and Mr. Justice Day, on Thursday. The Lancashire and Cheshire Telephone Company were rated by the overseers of Manchester in respect of certain wires owned by them passing over and being attached to various houses in that town. Mr. Webster, Q.C., now appealed against this rate on behalf of the telephone company, and Mr. Ambrose, Q.C., represented the overseers of Manchester in support. The case having been fully argued, Mr. Justice Mathew gave judgment for the respondents, upholding the rating of the wires, and in this judgment Mr. Justice Day fully concurred.

Underground Telephone Wires in Edinburgh.—The National Telephone Company has made application to the Edinburgh Town Council for permission to lay an experimental underground telephone line between St. Andrew's Square and the North Bridge.

Cable News.—The Haiphong direct cable has been opened.

The Forth Cable.—Last week telegraphic communication was all but stopped by the breakdown of the Forth cable, supposed to have been occasioned by the anchor of some vessel having come in contact with the cable, or by some other cause. Partial communication was subsequently renewed.

Cable Damaged.—The Post Office four-wire cable between Granton and Burntisland is again stopped. This cable is wholly used by the North British Railway Company for its traffic. Temporary accommodation has been given to the railway company by the seven-wire cable from Granton to Aberdeen.

Revenue of the Telegraph Service.—For the quarter ended June 30th, 1884, the telegraph service yielded a revenue of £440,000, as compared with £390,000 for the quarter ended March 31st, 1884; £435,000 to December 31st, 1883; and £485,000 to September 30th, 1883. For the year ended June 30th, 1884, the receipts were £1,750,000, against £1,735,000 for the year to June 30th, 1883.

The *Times*, in reference to these statistics, says:—"Mr. Childers postponed the proposed reduction in the charge for telegrams until August, 1885, on the ground that the Parcel Post had not fulfilled his expectations; but the increase of £5,000 in the telegraph revenue for the quarter will strengthen the argument of those who hold that the cheapening of one important service should not depend upon the success of another."

Breaking Telegraph Insulators.—At Manchester, on Monday, a number of youths were fined, some £1 and others £2 and costs, for throwing stones at telegraph wires, and thereby breaking a number of insulators. Mr. John Doherty, superintendent engineer of the telegraphs in the north-western district, stated that since the previous Friday no less than 54 insulators had been broken in that neighbourhood.

Divulging Telegrams.—The case of "The Central News Company *v.* The Eastern Telegraph Company" came before Justices Field, Manisty, and Lopes, in the Queen's Bench Division, on Thursday, last week. It was an application on behalf of the plaintiffs for a new trial of an action against the defendant company, Sir James Anderson, its managing director, and Mr. Benjamin Smith, its agent at Alexandria, for divulging a telegram sent by Mr. Burleigh, the special correspondent of the Central News in Egypt, whereby it was communicated to the Exchange Telegraph Company, and published in London and throughout England, before the original message could be sent out by the plaintiffs. The trial came on before the Lord Chief Justice and a special jury during the last sittings, when the jury found that the message was taken either directly or indirectly from a telegram sent by Sir Charles Wilson to Sir Edward Malet, but that the defendants had not divulged it to the detriment of the plaintiffs. On these findings his Lordship reserved judgment, and Mr. Murphy now moved for a new trial—no damages having been assessed. The Court was of opinion that it would be useless to proceed with the matter until the Lord Chief Justice gave his judgment on further consideration, and the arguments, therefore, were not proceeded with.

Sunday Work in Post Offices.—In reply to questions from Sir H. Maxwell and Lord Elcho, Mr. Fawcett explained that Sunday work in the Post Office in London had always been an exception, while in the provincial offices it had always existed. By the new classification, however, in 1881, the position of sorting clerks and telegraphists in the provincial offices with regard to Sunday work was considerably improved, as they were not ordinarily called upon to do more than eight hours' work in four Sundays, and if employed for a longer period than this were paid for overtime. Sir H. Maxwell asked why such Sunday work was reckoned exceptional in London, and not in the provinces. Mr. Fawcett said that there was less Sunday work in London, there being no delivery on that day.

Clark v. Bennett.—An action brought by Captain Arthur Hamilton Clark against Mr. James Gordon Bennett, the proprietor of the *New York Herald*, came before Mr. Justice Hawkins and a special jury on Monday. It was to recover compensation for services alleged to have been rendered to the defendant in connection with his project for laying a new electric cable across the Atlantic. The defendant paid £750, as compensation and £190 as expenses, and disputed his further liability. The Attorney-General, Mr. E. Clarke, Q.C., and Mr. Anderson were counsel for the plaintiff; Mr. R. E. Webster, Q.C., and Mr. Jeune were for the defendant. The Attorney-General, in opening the case, said the plaintiff was a native of Boston, in the United States, but for some years had carried on business in London as agent for American underwriters. Some years ago he became acquainted with Mr. Bennett, having taken charge of his yacht, the *Mona*, across the Atlantic, and in 1882 Mr. Bennett invited him to take a trip in his yacht, and while on the voyage mentioned that he thought of laying a new electric cable across the Atlantic, stating that Mr. Jay Gould had the control of the existing cables at the American end and Mr. Pender at the English end, and that the new cable was intended to enable him (Mr. Bennett) to overcome some journalistic rivalry which he had to encounter, as he would have substantial control over the cable. It was suggested that the plaintiff should be the first managing director of the company to be formed

for the purpose of working out the undertaking, at a salary of £3,000 a year, and his name had appeared in the articles of association. The plaintiff accordingly consulted Sir Charles Bright and a number of other scientific gentlemen in connection with the proposed scheme, and rendered various other services, for which he now brought his action, as the arrangement with the defendant had fallen through. The plaintiff was called in support of his case, but when it had proceeded some way it was agreed that it should be referred to an arbitrator to decide whether any more than the amount paid into Court should be paid to the plaintiff, "as between gentlemen."

The Corporation of Bristol v. The United Telephone Company.—Before Mr. Justice Cave, on Tuesday, the plaintiffs in this case claimed the right to have some kind of control over the erection of telegraph wires within their city; and they have claimed this, first, in the case where wires were carried over lands which were vested in them in fee; and, secondly, where wires, being carried over streets, might be a source of danger to the public. The Solicitor-General, Mr. Philbrick, Q.C., and Mr. Casserley were for the plaintiffs; and Mr. Webster, Q.C., and Mr. Moulton for the defendants. After some discussion it was admitted that the plaintiffs had absolute right of control where wires passed over their freehold land; and it was agreed that as to any other wire which was supposed to be a source of danger, that question should be decided out of Court. In the end the case was adjourned *sine die*, to allow time for this arrangement to be carried out.

The International Health Exhibition.—The Council of the Society of Arts, and the Executive Council of the Health Exhibition, have arranged for a *Conversazione* to be held in the buildings of the International Health Exhibition, South Kensington, next Wednesday evening. The visitors will be received by His Grace the Duke of Buckingham and Chandos, K.G., Chairman of the Executive Council of the International Health Exhibition, and by Sir Frederick Abel, C.B., D.C.L., F.R.S., Chairman of the Council of the Society of Arts. The reception will commence at 8.30 p.m. The gardens, as well as the exhibition buildings, will be lighted by the electric light; the gardens will also be illuminated with variegated lamps and Japanese lanterns, and the fountains will be illumined by means of electricity.

The Late Sir William Siemens.—A meeting was held on Thursday, last week, at the Institution of Civil Engineers, Westminster, to consider what steps should be taken to raise an engineers' memorial to the late Sir William Siemens. Sir Joseph Bazalgette, as president of the society, occupied the chair, and said it had been ascertained that it would be agreeable to the authorities of Westminster Abbey that a window should be erected in that building to the memory of the deceased. The cost of such a window might amount to between £700 and £800, and it was suggested that the subscriptions should be limited to one guinea each. It was resolved, on the motion of Sir C. H. Gregory, seconded by Mr. Edward Woods, that it would be desirable to commemorate the distinguished character and attainments of the late Sir William Siemens by erecting to his memory a window in Westminster Abbey, and that the subscriptions should be limited to one guinea, as suggested. An executive committee of three members from each of the five societies represented at the meeting, with Sir J. W. Bazalgette as chairman, was appointed to carry out the object of the meeting. The committee included Sir Frederick Bramwell, Mr. I. L. Bell, Sir Joseph Whitworth, Sir William Armstrong, Lord Ravensworth, Mr. J. D'A. Samuda, Sir Edward Reed, Mr. B. Samuelson, M.P., the Duke of Devonhire, Sir Henry Bessemer, Sir William Thomson, and Sir Frederick Abel. Mr. James Forrest was requested to act as hon. secretary and treasurer.

Primary Batteries.—We have often wondered who was responsible for the paragraphs relating to electrical matters which appear in the *leading* daily paper. Speaking of primary batteries, the writer says:—"Electric lighting by means of the primary battery would appear to have advanced another step by the introduction of the Lalande primary battery." Had the electrical expert of the *Times* kept himself acquainted with the tests which have been made with this battery, the only truthful conclusion at which he could have arrived would have been that instead of advancing, a retrograde movement had been the result. A necessary qualification for the economical production of the electric light by means of primary batteries is a high electromotive force, and the Lalande element has about the lowest with which we are acquainted. The writer further states that the battery is said to be capable of supplying a current for 15 glow-lamps of 10 candle-power each, and this point was fully demonstrated by an excellent and steady light by *nine* Woodhouse and Rawson lamps. The statement that the battery remains constant so long as the elements remain efficient, would, we opine, apply to any other kind of "cell" under the same conditions. For the benefit of such of our readers as have not carefully studied the tests on this battery, published in our last issue, we reproduce a portion of Dr. Van der Ven's paper. "It is evident that it cannot be used for purposes which require a great difference of potential between the different parts of the circuit. Thus, *e.g.*, it follows that an Edison lamp (with a resistance of 54 ohms, $I = 0{\cdot}9$) would require a battery of about 82 elements in series to illuminate with an intensity of 13 candles. In the same manner, a Swan lamp (resistance 36 ohms, $I = 1{\cdot}2$) would require 74; a Maxim lamp (resistance 27, $I = 1{\cdot}4$) about 70; and a Lane-Fox lamp (resistance 24·5, $I = 1{\cdot}5$) about 67." Of course, Dr. Van der Ven does not imply that the elements above enumerated would not supply current for more than one such lamp, but only that, by reason of the low electromotive force, it is necessary to use about twice as many cells to get a given difference of potential, as is the case with other batteries which have been tried for electric lighting. With regard to the bye-products, we learn that although the invention of the battery is due to M. Lalande, the credit of utilising it for the manufacture of oxide of zinc belongs to Mr. J. Berger Spence, the head of the firm of manufacturing chemists bearing his name. Now that the question of primary batteries has been taken up by Mr. Berger Spence, surely the whole electrical world may rest and not trouble itself any further.

Secondary Battery Cells.—Mr. Frederick John Smith, B.A., has kindly sent us the following communication:—"Considerable trouble has been felt by those who are engaged in practical problems connected with secondary batteries, arising from imperfections in the cells for holding the dilute acid, and also from the fact that the plates of a charged secondary battery cannot be lifted out of the liquid, in order that any required area may be exposed to the action of the acid, without the rest of the reduced lead on the kathode plates being at once acted on by the oxygen of the air. To meet these difficulties I have carried out the following methods:—The cells are made of common pottery ware, about 2 c.m. thick, all sharp corners should be avoided in the moulding of the cells, because they do not stand the process of cooling well, while rounded corners seldom crack during cooling. These rough porous cells are warmed slowly in an oven, to such a temperature that paraffin-wax melts easily when rubbed against them. The cells on being removed from the oven are partly filled with paraffin-wax; this is made to run well over the whole inner surface of the cell. As soon as the wax begins to set it is poured out, and the cell is put away to cool. A cell so made stands acid well, and the dilute acid does not creep up the sides of the cell, as it does in the common glazed cell. Another method, used at an earlier date than the one just mentioned, was to make

deal boxes of the size required, and place inside them card boxes (held out by sand), so that there was a space of about 1 c.m. between them. This space was filled with common paraffin-wax, then the card box being removed, a perfect lining of wax was left. This method is more costly than the last, but has the advantage of greater strength. The test of two years' constant use has shown that both these forms of secondary battery cells are both practical and lasting. When using a secondary battery in the laboratory, it would be sometimes convenient to be able to expose only some part of the plates to the action of the dilute acid, but as things now are, this cannot be done without the part of the plates which are lifted out, being at once acted on by the oxygen of the air. To prevent this action taking place, the plates are drawn out of the liquid into the vapour of benzol. (After several experiments with different gases, this appeared to answer well and to be easily managed.) By this means the injurious action mentioned is prevented, and any required amount of surface of plate may be exposed to the action of the dilute acid."

Conferences at the International Health Exhibition.—Yesterday, at the International Health Exhibition, papers were to be read under the auspices of the Society of Telegraph Engineers and Electricians, "On Electric Lighting in Relation to Health," by Mr. R. E. Crompton; and upon "The Physiological Bearing of Electricity on Health," by Dr. W. H. Stone, M.A., M.B., Oxon, F.R.C.P. The President, Prof. W. Grylls Adams, F.R.S., was announced to preside. The syllabus of the first-named paper was as follows:—Conditions of life under artificial light not so favourable to health as those under sunlight—Causes of this (*a*) Those affecting the general health—(*b*) Those affecting the eyesight more particularly—Electric light nearest approaches sunlight, is therefore most favourable to health of all artificial illuminants—Comparison of the heating and air-vitiating effects of 11 different illuminants—Effects on the general health of insufficient light—Why artificial light, previous to electric light, invariably insufficient—Lighting by the arc and by incandescence—Proper uses of both kinds—Effects of electric light on the eyesight—Fatigue to the eyesight from insufficient light, from unsteadiness, from bad colour—Comparative steadiness of arc and incandescent light—Colour of both classes—Effects on eyesight of workpeople using both classes—Results of various well-known installations, House of Commons, Law Courts, Savoy Theatre, &c.—Effects on children—Advantages of electric light indirectly affecting health—Safety—Additional pleasure from flowers, pictures, and all coloured decorative objects — General exhilaration caused by a plentiful supply of pure white well-diffused light—Absurdity of current ideas as to danger to person from use of electricity. The syllabus of Dr. Stone's paper was as under:—Electricity, as at present used, is at once a source of danger, a possible cause of sickness, and a remedy. In all these cases it has been insufficiently studied, and continues to be ill understood. This condition of affairs is probably due to the fact that from the great subdivision of modern science, a competent knowledge of physics as well as of physiology is rarely acquired by the same person, whereas, for accurate work, it is essential that so powerful an agent should be measured by accepted units. What little has been done by the physiologists is marred by considerable errors as to the force actually in use. *Dangers.*—1. To sight will be very briefly. 2. To life and health more minutely adverted to. Causes of death may be:—1. By catalytic action. 2. By thrombosis of the larger vessels. 3. By shock and syncope, due to action on the cardiac nervous system. *Remedial and physiological points.*—1. Common errors corrected. Imperfect contact. 2. Approximate determination of the electrical resistance of the human body to low and high tension currents respectively. 3. Use of the telephone and meter bridge for measuring this resistance. 4. Measurements of E.M.F. of high tension alternating currents by dynamometer and quadrant electrometer.

City and Guilds of London Institute.—Specimens of Apparatus used in the Electrical Engineering and Applied Physics Laboratories of the Technical College, Finsbury, are on exhibition in the Educational section of the International Health Exhibition. Mr. W. E. Ayrton, F.R.S., is the professor at the college in the departments of electrical engineering and applied physics. The main object of the course of instruction is to train students in the application of the laws of physics to industry, and to lead them to see how such an application can be used to improve and cheapen industrial operations. The instruction is analytical rather than synthetical. The student's attention is first directed to a complete apparatus or machine; its action and the practical results obtained with it are then considered; and, finally, the scientific principles that underlie its correct working are evolved. The education is given partly by lectures, but mainly through the laboratory work of the students themselves. The laboratory contains many arrangements of apparatus for an organised series of experiments, each set complete in itself, so that the students will find ready in position all the apparatus necessary for carrying out *seriatim* a large number of experiments. Full printed instructions are appended to each experiment, and copies are supplied to the students. The students work in the laboratory in groups of three, these groups being arranged so that students whose knowledge is about the same work together. The experiments are performed as nearly as possible in a specified order; and before a group of students is allowed to pass on to a new experiment, each member is required to show to the professor, or one of the demonstrators, his written-out notes of the previous experiment, including any deductions he may have made from it. After any student has completed all these experiments in the regular course, he is set to carry out what may be called scientific commercial experiments—that is, the kind of experiments a master of a works might arrange to have undertaken, to enable him, by the application of the principles of science to his trade, to turn out the articles he manufactures in the best and cheapest form. The special industries in connection with which applied physics is at present taught at the Finsbury Technical College are those involving the use of electricity or heat.

The Inventors' Institute.—The members of this institute, with a few invited friends, assembled at the International Health Exhibition, South Kensington, on Wednesday, the 2nd inst. Mr. S. J. Mackie conducted the party round the building to various exhibits, mostly consisting either of sanitary inventions or educational systems, and also through the laboratory of natural science, where many specimens of fungoid growth were to be seen; some of natural production from germs floating in the atmosphere, whilst others were cultivated, or more properly inoculated, the subjects being the inner surface of divided boiled potatoes. Specimens were also shown of bacteria, which in their normal condition are death to divers animals, but when attenuated after the fashion of vaccine, lose their fatal properties. The credit of this discovery belongs to M. Pasteur, the celebrated French physiologist, who has followed in the footsteps first traversed by Dr. Jenner. The educational department, under the auspices of the "Christian Brothers," represents the manner of teaching boys in a thoroughly practical way, progressively from the first rudiments of knowledge upwards, until they are fitted to take their places in the world, competent to carry out any work to which they have been trained; the system of tuition being the same—with a few alterations to suit local peculiarities—all over the world. Mr. Donald Nicoll explained his manner of treating sewage, ashes, and garbage from private houses; and Mr. Hagard exemplified a process whereby London might be rendered smokeless, as all carbonic acid generated in the consumption of the fuel is converted into a carbonate of a solid form. Later on, the party sat down to a banquet in the jury room, Vice-Admiral Jasper Selwyn in the chair,

supported by Mr. J. E. Spagnoletti, J. Stansfield, Captain Fairholme, &c. At the close of the repast, after the toasts of the Queen, the Prince and Princess of Wales and the rest of the Royal Family, had been enthusiastically responded to, the chairman coupled the name of the Army with that of Colonel Hope, V.C. In reply, that gentleman stated the immensity of trouble it required to bring a useful invention before the Government, and as an instance, he mentioned an improvement that could be made in regard to ordnance. The first person to be seen was the Marquis of Hartington, the Secretary of State for War, who knew very little about it; from him reference would be made to some one else, who knew less, and who would further refer to the Surveyor-General of Ordnance. It might be thought from his title that the latter would be fully acquainted with all matters connected with his special branch, but he in reality was a member of Parliament, pitchforked into a position without any special qualification for the post. From the Surveyor-General the invention would be sent to some lower officials, who, if it so pleased them, would send it to a special committee to adjudicate upon. Unfortunately, this committee had no power of originating or proposing anything that might be useful to the country. In place of this roundabout process, the gallant colonel thought the matter of improvements ought to be placed in the hands of men who had brains to originate an idea, and the scientific skill to carry it out; men like Professor Tyndall and Sir William Thomson. Captain Fairholme responded for the Navy, praising the discipline and appearance of the men of the British Navy. Mr. Gooch proposed the toast of the Inventors' Institute, coupled with the name of Mr. J. Stansfield, C.E., who, in the course of his remarks, declared that by the inventions of the celebrated Trevithick, every Englishman was capable of doing the work of three men; that this country in consequence could support 30,000,000 of people instead of about 10,000,000; and that by means of the power of transport possessed by railways, famines were averted. It had been said that the British nation could only improve, not invent. This statement the speaker entirely disbelieved in; the reason why so few patents, comparatively, were taken out, had hitherto been the prohibitory price of Government stamps. In 1852, the Conservative party reduced the patent fees from £300 to £170. A great increase in the number of patents granted was at once observable. The number of patents issued here had been unfavourably placed in comparison with that passed through the American Patent Office. Last year the Americans took out 15,000; but since the reduction of preliminary fees in this country, there had been 5,000 applications within the first three months of this year. The proceedings terminated shortly after 10 o'clock. The Inventors' Institute, which is of long standing, and has been instrumental in promoting and rendering aid in forwarding all the improvements that have been made in Patent Law during the last 30 years, is desirous now of bringing itself more prominently before the world in the endeavour to obtain for a patent taken out in one country protection in every other, and to make one fee sufficient to cover all charges for international rights. The Institute appears to us to be worthy of more substantial support than it is receiving at the present moment.

Civil Service Commissioners' Report.—From the report of the Civil Service Commissioners for 1883, we learn that for 160 vacancies for male and female telegraph learners there were 1,848 candidates, of whom 1,682 were females.

Lancashire Maxim-Weston Electric Light Company.—With a view to taking united action, creditors of this company are requested to forward their names and addresses to Mr. H. Alabaster, ELECTRICAL REVIEW, 22, Paternoster Row.

NEW COMPANY REGISTERED.

Self-Propelling Motor Syndicate, Limited.—Capital, £20,000 in £5 shares. Objects:—To trade as mechanical and chemical engineers, manufacturers of engines, and as workers and dealers in electricity, motive power, and light; and to carry on any business in which the application of electricity or other power may be useful. Signatories (with 1 share each):—Lieut.-General C. E. Parke Gordon, St. Luke's Road, Westbourne Park; George Milburn, Edinburgh; Robt. Laing, Newcastle-on-Tyne; S. W. Smith, 66, Gresham House; H. W. Rollison, 11, Wellington Street, Strand; C. H. Hosking, Lower Clapton; W. Rivett, Leyton. The Signatories are to nominate the first directors, and are to act *ad interim*, qualification, 50 shares; remuneration, £100 per annum for each director. Registered 1st inst. by Richard Hewlett, 30, Essex Street, Strand.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Railway and Domestic Electric Lighting Company, Limited.—Under an agreement dated 16th ult., and filed on 23rd inst., this company will purchase the goodwill and business of the Electric Company, Limited, for six fully-paid shares of £100 each. This company will also purchase from Messrs. G.C.V. Holmes, F. E. Burke, and J. Oliphant Byrne their patent rights in regard to the system of generating electricity by primary batteries, embodied in the inventions in connection with the Grahame batteries, and for the manufacture of commercial products resulting from the operation thereof. The purchase consideration is 30 fully-paid shares of £100. Mr. G. C. V. Holmes is to be appointed consulting electrician for five years, at such remuneration as he and the directors may determine.

The registered office of the company is situate at the Adelphi Electric Works, Adelphi Terrace, Strand.

J. B. Rogers Electric Light and Power Company, Limited.—An Order of the Chancery Division of the High Court of Justice, filed, with the documents of this company, on the 23rd inst., appoints Mr. Frederick George Painter, of 2, Moorgate Street Buildings, official liquidator, and directs that on the 29th of May, 1885, and on the same day in each succeeding year, he shall leave his accounts at the chambers of Mr. Vice-Chancellor Bacon. The order also authorises Mr. Painter to receive all moneys and to pay the same into the Bank of England to the credit of the account of the official liquidator.

CITY NOTES, REPORTS, MEETINGS, &c.

The Pilsen-Joel and General Electric Light Company, Limited.

IN reply to a circular issued by Messrs. J. G. Osborne & Co., the following has been forwarded to the shareholders of the above company by its secretary:—

"I am directed by the board of the Pilsen-Joel and General Electric Light Company, Limited, to state that their attention has been called to a circular, dated June, 1884, promulgated by Messrs. J. G. Osborne & Co., respecting the position of this company and its directors.

"The directors would, in the first place, observe that Messrs. Osborne have not sent their circular to all the members of the company, but have only despatched it, so far as can be ascertained, to those shareholders who, from their position, cannot be fully aware how false and absurd Messrs. Osborne's statements are.

"Dealing shortly with these statements, the directors would wish to inform their shareholders—

"That the action against Messrs. Osborne & Co. was abandoned because the scheme for the reduction of the capital having been adopted at a large meeting of the shareholders with only two dissentients, the directors felt that Messrs. Osborne & Co. were powerless for harm, and that, therefore, the board were not justi-

fied in continuing a litigation of which the object was no longer adequate to the expense which would have been incurred.

"The insinuation that the chairman has any interest in the firm of Woodhouse & Rawson, or their contracts, is utterly without foundation.

"The loan to Messrs. Ellis was a temporary investment, *made on the fullest security* and in the usual course, for the purpose of obtaining the best interest for the company's surplus balance, and it is utterly untrue that it was made, as insinuated, for the purpose of rigging the market for the company's shares, or that the directors have any knowledge of the market being so rigged.

"The sum to be paid for the acquisition of the fully paid shares is not £21,000, but less than £14,000, and the object and effect of the scheme are to relieve the shareholders from a large proportion of their liability.

"Messrs. Paines, Layton and Pollock retired from the solicitorship of the company for the reason that one of the partners was a director of the Gas Light and Coke Company; they did this to the regret of the directors, whose hearty goodwill they had earned and continue to possess.

"It is untrue that they hold any promoters' shares in the Pilsen Company.

"It is untrue that Mr. Horne is a director either of the Pilsen Company or of the Union Company.

"The allegations and insinuations affecting the Union Company do not concern the Pilsen Company, but your directors are informed that they are as unfounded as those above referred to.

* * * * * * *

"It is the intention of the directors at their approaching annual meeting to lay the whole position of the company before their shareholders, and to ascertain their views as to the future."

Where the asterisks are placed has been omitted a paragraph consisting of a counter attack on Messrs. Osborne & Co., which we do not think it necessary to reproduce here. When such interests as these conflict, then one gets at the truth. With regard to the last item of intelligence, it was to be expected that the shareholders' views as to the future would be desired when the directors had gone nearly to the length of their tether, but we venture to opine that so long as they can call up capital with a chance of getting it, the shareholders' views would remain at about an equal discount with the company's shares.

The London and Globe Telephone and Maintenance Company, Limited.

THE following circular has been issued to the shareholders of this company by the directors:—

"No sufficient response having been made to the invitation to the shareholders last December to subscribe to the proposed issue of £65,000 in debenture bonds, for the purpose of carrying on the business of this company, and it having further proved impossible to raise the funds required in the manner proposed in the circular issued by order of the directors on the 10th of January, 1884, the board have been reluctantly compelled to consider the advisability of winding up the business, or of finding some means of disposing of a portion of the property in a manner which should prove as satisfactory to the shareholders as circumstances permit.

"I am now desired to inform you that the directors, having given their earnest attention to this matter, and having opened negotiations with various parties, both in this country and in the United States, have finally, subject to your approval, accepted as the best offer obtainable, a proposal from the United Telephone Company, Limited. Under the terms of this proposal, the United Telephone Company buy the company's exchange, patents, business, goodwill, &c., for the United Kingdom for the sum of £25,000, in cash, and an interest in subsidiary companies to be formed for working and developing in conjunction with the United Company, the telephone business in certain provincial districts.

"It is with great regret that the directors are obliged to counsel the abandonment of the business which they have been developing in the metropolis, but they are glad to be able to point out that the proposed arrangement with the United Telephone Company will clear this company from all existing liabilities, leave it possessed of a certain sum in cash, of its foreign patents, and a still valuable interest in Great Britain; and they therefore feel assured that you will confirm with approval the proposal which they have provisionally accepted."

Eastern Telegraph.—After placing £65,000 to the Reserve Fund a dividend of 3s. per share will be paid, less income-tax, being at the rate of 6 per cent. per annum on the preference shares. Also a final dividend of 2s. 6d. per share with a bonus of 1s. per share, free of income-tax, on the ordinary shares, making, with previous payments on account, a total dividend of 6 per cent. for the year ended 31st March, 1884; a balance of about £2,500 will be carried forward.

Metropolitan (Brush) Electric Light and Power Company, Limited.—The creditors of this company are requested, on or before Monday, July 28th, to send their names and addresses, and the particulars of their debts or claims, together with the names and addresses of their solicitors (if any) to the liquidators, Admiral Sir Edward Augustus Inglefield, Alexander Peebles, Lawrence Engel and Charles Bell, at their office, No. 2, Walbrook, E.C.

The Great Northern Telegraph Company.—It is notified by this company that a uniform rate of 10s. per word will now be charged for messages from the United Kingdom to all land line stations in China. The rates to China will, therefore, until further notice, be as follows:—Shanghai, Amoy, Hongkong, and Foochow, 8s. 4d. per word; all other stations 10s. per word.

Western Union Telegraph.—A dividend for the quarter ending 30th June of 1¾ per cent. on the capital stock is payable on the 15th of July to shareholders of record on the 20th instant.

Eastern and South African Telegraph Five per Cent. Mortgage Debentures.—The Coupons due on the 1st inst. will be paid by Messrs. Barclay, Bevan & Co. on and after that date.

LATEST QUOTATIONS.

Authorised Issue.	Share.	Name.	Paid.	Closing Quotatns, July 3.	Business Done.
		ELECTRIC LIGHT.			
40,000	10	Anglo-American Brush Co.	8	1¼ - 1⅝	
		Do. Do.	10	3 - 3½	
30,000	5	Australasian E. L., Power & Storage Co.	3½	..	
24,900	10	British Insulite Co., Ld., "A" Shares.	6	..	
25,000	5	Gt. Western Electric Light & Power Co.	2½	⅛ - ¼	
24,980	5	Hammond Elec. Lt. & Power Sply. Co.	5	⅛ - ¼	
40,000	5	Indian & Ori. Electl. Storage Wks. Co.	2½	..	
250,000	1	Maxim-Weston Elec. Lt. & Power Co.	1	¼ - ½	
100,000	5	Metrop. Brush Electric Lt. & Power Co.	3	..	
40,000	5	Pilsen-Joel & Gen. Elec. Lt. Co.	3½	..	
20,000	5	S. African Brush Elec. Lt. & Power Co.	2½	..	
100,000	5	Swan United Electric Light Co., Ld.	5	⅛ - ¼	
		TELEGRAPHS.			
1,892,480*l.*	Stk.	Anglo-American, Limited	100	31 - 32	
2,533,760*l.*	Stk.	Do. Pref. } Def. receiving no div. until	100	55½ - 56½	55½
2,533,760*l.*	Stk.	Do. Def. } 6 p. c. paid to Pref.	100	6½ - 7	
130,000	10	Brazilian Submarine, Limited	10	9⅞ - 10	9⅞
16,000	10	Cuba, Limited	10	9½ - 10½	
6,000	10	Do. 10 per cent. Preference	10	16½ - 17½	
13,000	10	Direct Spanish, Limited	9	4½ - 5	
6,000	10	Do. 10 per cent. Preference	10	14½ - 14¾	
65,000	20	Direct United States Cable, Ld., 1877	20	9½ - 9⅞	9 15/16, ⅞
100,000*l.*	100	Do. 6 per cent. Deb., repayable 1884	100	98 -102	
380,000	10	Eastern, Limited	10	11 - 11½	11⅛, 11
70,000	10	Do. 6 per cent. Preference	10	13⅞ - 14¼	
200,000*l.*	100	Do. 5 do. Debs., repayable Aug. 1887	100	102-105	
200,000*l.*	100	Do. 5 do. do. Aug. 1899	100	103-107	
500,000	Stk.	Do. 4 do. Debenture Stock	100	96 - 98	96⅞
250,000	10	Eastern Exten., Australasia & China, L.	10	11⅛ - 11⅜	11 7/16
320,000*l.*	100	Do. 6 p. c. Debs., repayable Feb. 1891	100	109 - 112	
500,000*l.*	100	Do. 5 p. c. (Aus. Gov. Sub.) Deb. 1900	100	102 - 105	
140,000*l.*	100	Do. reg., repayable 1900.	100	102 - 105	102⅞
100,000*l.*	100	Do. 5 per cent. Debenture, 1890	100	102 - 104	
550,000*l.*	100	Eastern & South African, Ld., 5 p. c. Mort. Deb. Rg. redeemable 1 Jan. 1900	100	101 - 104	
	100	Do. do. do. To Bearer	100	101 -104	
20,050	10	German Union Telegraph & Trust, Ld.	10	9½ - 9⅝	
250,000	10	Globe Telegraph & Trust, Ld.	10	6½ - 6⅞	6⅝
250,000	10	Do. 6 per cent. Preference	10	12½ - 12⅝	12½, 5/16, ⅜
150,000	10	Great Northern	10	13⅛ - 13⅜	13⅜
100,000*l.*	100	Do. 5 per cent. Debentures	100	100 -103	
300,000*l.*	100	Do. 5 per cent. Debentures	100	102 -105	
81,200	10	India-Rubber, Gutta-Percha, & Tel. Wks.	10	20½ - 21½	
100,000	100	Do. 6 per cent. Debs., 1886	100	100 -103	
18,000	25	Indo-European, Limited	25	30 - 31	
40,000	10	London Platino-Brazilian, Limited	10	3 - 3½	
100,000	100	Do. 6 per cent. Debentures	100	100-102	
12,000	10	Mediterranean Extension, Limited	10	1½ - 1⅝	
3,200	10	Do. 8 per cent. Preference	10	2 - 4	
10,000	8	Reuter's, Limited	8	8 - 8½	
338,225*l.*	Stk.	Submarine	100	153 -158	157
75,000	1	Do. Scrip	1	1⅛ - 1⅜	
4,200	Cert.	Submarine Cables Trust	100	99 -102	
37,350	12	Telegraph Construction and Mainten.	12	30½ - 31½	31½
150,000	100	Do. 6 per cent. Bonds, 1889	100	104 -106	
186,750	5	Do. 2nd Bonus Trust Cert.	2½	1⅛ - 1⅜	
30,000	10	West Coast of America, Limited	10	6½ - 6⅝	
150,000*l.*	100	Do. 8 per cent. Debs.	100	106 -108	
45,791	15	Western and Brazilian, Limited	15	5 - 5⅛	5
24,119	7½	Do. Preferred	7½	4⅛ - 4½	
24,119	7½	Do. Deferred	7½	⅛ - 1⅛	
200,000*l.*	100	Do. 6 p. c., Debs. "A" 1910	100	102 -105	
250,000*l.*	100	Do. 6 p. c. Mort. Deb. B. '80, red. Feb. 1910	100	97 -100	
1,500	$1,000	Western Union 7 p. c. 1 Mort. (Bg.) Bds.	$1,000	121 -125	
1,050,000*l.*	100	Do. 6 per cent. Sterling Bonds	100	102 -106	
88,321	10	West India and Panama, Limited	10	⅛ - ¼	
34,563	10	Do. 6 per cent. 1st Preference	10	6 - 6½	
4,669	10	Do. 6 do. 2nd do.	10	4½ - 5½	
		TELEPHONES.			
224,850	1	Con. Tele. & Mainten., L., Nos. to 154,165	1	15/16 - 1	
225,000	1	Oriental Tele. Co., Nos. 80,001 to 300,000	¼	⅜ - ½	
100,000	5	United Telephone Co.	5	9⅞ - 10½	9 15/16
20,000	5	Do. New, issued at £2 pm.	2	4½ - 4¾	

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of June was 3,531, estimated to produce £3,150 against 3,120 messages, producing £2,688 in the corresponding month of last year. The receipts for the month of March, estimated at £3,200, realised £3,296.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 30th June, are £3,071 as compared with £2,529 in the corresponding period of 1883.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending 27th June, were £2,377, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of June are £1,345, against £1,556 in the corresponding period of last year.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending June 30th, 1884, £3,615.

NEW PATENTS—1884.

9377. "Rotary hair brushes adapted for applying electricity to the human scalp." W. TAPP. Dated June 25.

9409. "Electric generators." A. SPÖREL. Dated June 25.

9411. "Maintaining a uniform arc in an electric lamp without the aid of clockwork or like mechanism or shunt coils." W. ROWBOTHAM. Dated June 25.

9412. "Apparatus for refreshing galvanic batteries." A. M. CLARK. (Communicated by A. Dun.) Dated June 25.

9415. "Electric fuses." J. MACNAB, J. H. BLAND. Dated June 25.

9459. "Apparatus to be used in working dynamo machines by motive power applied in different directions or for analogous purposes." F. THORNTON, F. V. ANDERSEN.

9462. "Apparatus for automatically completing or interrupting the circuit, as required in charging storage batteries." F. THORNTON, T. V. ANDERSEN. Dated June 26.

9471. "Membrane telephones." S. P. THOMPSON, P. JOLIN. Dated June 27.

9488. "Secondary batteries." A. TRIBE, A. P. PRICE. Dated June 27.

9489. "Construction of secondary batteries." A. TRIBE. Dated June 27.

9536. "Ring armatures of certain dynamo-electric or electro-dynamic machines." R. E. DUNSTON. Dated June 28. (*Complete.*)

9550. "Apparatus for the reproduction at a distance of characters, signs, delineations and motions." T. TUBINI. Dated June 28.

9551. "Apparatus for the reproduction at a distance of characters, signs, delineations and motions." T. TUBINI, G. C. COOKE. Dated June 28.

9578. "Applying magnetic action to produce electro-chemical action." F. J. BOLTON, R. H. WOODLEY. Dated June 30.

9607. "Electric contact makers or indicators." W. A. LEIPNER, C. BROTHERHOOD. Dated July 1.

9649. "Incandescence electric lamps." H. H. LAKE. (Communicated by by G. S. White.) Dated July 1. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1883.

5031. "Electro motors, &c." A. RECKENZAUN. Dated October 23. 6d. The object of this invention is, firstly, to provide means by which the so called Foucault currents set up by a mass of metal moving in a magnetic "field" can be almost entirely avoided and whereby also the core of an armature constructed in accordance with the invention possesses the advantages of lightness combined with efficiency. And secondly, in an arrangement for increasing the magnetic "field" of electro motors, dynamo or magnetic machines having a hollow drum or ring armature.

5110. "Generation, storage, regulation, distribution, &c., of electricity." J. S. WILLIAMS. Dated October 27. 1s. 2d. Consists in improvements in and relating to the generation, storage, regulation, distribution, measurement and utilisation of electricity, and in apparatus, methods or means therefor; and in apparatus, devices or means employed in the construction or working of an apparatus or system of electrical distribution.

5299. "Electric arc lamps." H. SPRINGMANN. (A communication from H. A. Earle and E. Goltstein, both of Hanover.) Dated November 9. 2d. Relates to electric arc lamps in which the distance of the two carbons from each other is regulated by the flow of a liquid controlled by the electric current, and the chief improvement consists in operating, by means of the current, a piston adapted to exercise a pressure on the liquid, and thereby to separate the carbons when the lamp is switched into the circuit, the piston acting subsequently as a valve to limit the flow of the liquid according to the length of the luminous arc. *(Provisional only.)*

5371. "Batteries for electric lighting, &c." J. NOAD. Dated November 14. 6d. According to this invention the inventors place within one or more outer cells of glass, earthenware, or other acid proof material, an inner porous cell or inner porous cells provided with a lip or channel hanging over the outer cell or cells to carry off the rising solution to be utilised. The inner or outer cell or cells is or are provided with an iron plate or iron plates and charged with nitro hydrochloric acid (nitro muriatic acid) to which water is added. This exciting solution is used for starting the inner cell or cells. The outer cell or cells is or are fitted with a carbon plate or plates and charged with nitric acid, sulphuric acid and nitre (preferably in the form of crystals) and diluted with water, according to the battery power required; this is for quantity, but for intensity the inventors reverse the order and place the carbon plate or plates in the inner cell or cells and charge with the solution just above mentioned. If coupled up for lighting purposes they couple iron to carbon, but if for the deposition of metals or for motive power, they couple up all iron and all carbon.

5408. "Magneto-electric and dynamo-electric machines." G. HOOKHAM. Dated November 16. 2d. Consists mainly of improvements in or modifications of an invention for which Letters Patent were granted to the inventor, dated 21st April, 1883, No. 2042, and instead of employing only one series of steel or permanent V shaped or bar magnets arranged radially on a rotating shaft, the inventor employs two series of the said magnets on the same shaft and at a short distance apart, the magnets of the two series being so arranged on their common shaft that the arms or poles of each magnet of one series are opposite to arms or poles of different polarity on the other series. In other words, the north pole of each magnet of one series is opposite the south pole of a magnet of the other series. There is thus formed a powerful magnetic-field between the poles of the magnets of the two series, the lines of force in which magnetic-field will pass through an armature connecting or nearly connecting the two opposite magnets, and induce an electrical current in a coil on the said armature. The armatures are fixed in a circular frame within which the two series of magnets rotate, the coils on the armatures occupying only the middle of the armatures and ordinarily having a length somewhat less than the breadth of the space between the two series of magnets, so that as the magnets rotate they are free of the said coils. The armatures are of such a length as to extend over the whole face of the ends of the magnets. (*Provisional only.*)

5417. "Primary voltaic batteries." D. G. FITZ-GERALD and T. J. JONES. Dated November 16. 4d. Relates to improvements in primary voltaic batteries, wherein the inventors employ as the negative element lead or carbon in contact with peroxide of lead, such peroxide being preferably obtained by the electrolysis of an oxide or salt of lead, or by the conversion of spongy lead into peroxide. When carbon is employed as the negative element it may advantageously be in the form of small fragments surrounding a rod or plate of the same material, the interstices between the carbon fragments being filled with lead peroxide; or when carbon is used the lead peroxide may be replaced by a solution of chromic acid obtained electrolytically. As the positive element the inventors employ lead in a highly porous condition, as obtained by a greater or less degree of compression of the metal reduced from its oxides or salts by chemical decomposition or by electrolysis, or by the compression of lead in a state of minute subdivision produced by mechanical means. As the electrolyte they use dilute sulphuric acid preferably, holding in solution a small proportion of sulphate or tartrate of ammonia.

5419. "Magnetic and electrical apparatus for the treatment of the nerves and muscles connected with the human eye and ear." S. Mason and C. R. Huxley. Dated November 16. 2d. Relates to certain devices or appliances by which the inventors design to place the nerves and muscles surrounding and connected with the human eye and ear within the influence of a magnetic field, inducing electrical currents in the moving fluids of the body, or directly under the influence of an electric current. (*Provisional only.*)

5429. "Lighting trains by electricity in combination with gas." E. EDWARDS. (A communication from abroad by D. Tommasi, of Brussels.) Dated November 17. 2d. Has for its object improvements in apparatus by which gas and electricity (generated by a dynamo-electric machine set in operation by the movement of the train which is to be lighted) can be used simultaneously or alternately. The improved apparatus consists of a dynamo or magneto-electric machine of either continuous or alternate current, and of any of the ordinary well-known kinds, set in motion by one of the axles of the train which is to be lighted. Insulated wires conduct the current so generated to incandescent lamps of any of the ordinary well-known kinds contained in the compartments of the carriages. An automatic commutator is inserted in the circuit, and is arranged so that whenever the intensity of the electric current is lessened a sufficient quantity of gas is automatically supplied to ordinary gas burners. (*Provisional only.*)

5851. "Electric clock regulators." R. H. BRANDON. (Communicated by J. F. Kettell, of America.) Dated December 24. 6d. Relates to improvements in electric clock regulators, has especial reference to improved apparatus and means for "setting" one or more clocks, and the main object of the improvements is to enable the electric conducting wires to be used, if desired, for telephonic or telegraphic purposes, except during a brief period or periods of the day when the clocks are to be set.

1884.

3134. "A spring buffer and bracket for transmitting electricity to and from any number of engines, carriages, trucks, or vehicles in a train on railway or common roads." W. TOWELL. Dated February 12. 4d. The bracket, in which is fitted the buffer and spring, is placed on the end of a carriage, a similar bracket buffer and spring is fitted on the opposite end of the carriage; in the end of the buffer, inside of the bracket, a hole is provided for attaching two wires; these wires may then pass around, or through the carriage, and be connected with the end of the buffer inside the bracket at the opposite end of the carriage; any number of engines, carriages, trucks, or vehicles fitted with these brackets and buffers, so that when the carriages are coupled up the buffers touch each other, the circuit for transmitting electricity is com-

plete, and ready for attaching an instrument for transmitting a message or signal from one carriage to another, if in a railway train, from the guard's van to any carriage, or to the engine, or from the engine to any carriage, or to guard's van, suitable dials, bells, or gongs being provided.

CORRESPONDENCE.

Telegraphic Apparatus.

In the years 1880-1, there appeared in the ELECTRICAL REVIEW a series of excellent papers on Post-office Telegraphic Apparatus. Since the conclusion of the series, important improvements have been effected on quadruplex transmitters, &c., and from conversations which I have had with readers of your journal, I feel certain that some particulars of these improvements would be most acceptable to a very large number of your readers.

Trusting you will at no distant date find space to supply this want, I am

Fareham.

Induced Continuous Currents.

M. F. de Wolffers' so-called continuous current induction apparatus, which formed the subject of an article in your issue of June 14th—to judge from M. F. de Wolffers' theoretical reasoning—is evidently based on a misconception of the elementary principles of electro-dynamics, and is simply a useless modification of the invention described in my specification, *part* of which was published in the REVIEW, January 19th last.

The fact is M. F. de Wolffers has been working on a false theory; the article in question is a sufficient proof of this, and I am not surprised at M. F. de Wolffers' inability to identify his apparatus with that described in my specification, when his theoretical views are considered.

The principle of my apparatus is explained in another column, and it is actually a representation of my "motor-induction machine" *at rest*. The *constructive* difference between M. F. de Wolffers' drawing and my own is a matter of degree only.

Let us suppose there are 24 sections of bobbins on an ordinary Gramme ring, and let the latter be excited so as to develop the two poles in the usual way; the induced electrical effect at each advance of the moveable commutator or brushes (according to M. F. de Wolffers' drawing), will be the resultant electrical effect of the magnetic change of that part of the core which is occupied by the two opposite bobbins in which the commutator has caused a reversal of current, the direction of current in all the other bobbins remaining the same, so that the only inductive effect that could be obtained in one revolution of the brushes would be that of *two bobbins only*, $\frac{2}{24}$ or $\frac{1}{12}$ of the ring as a whole.

It is easy to see that for practical purposes this would be useless. I prefer two or four sections of bobbins, according to the size of the machine, which makes it, practically, of the alternating Gramme type. The induced electrical effect at each change of the commutator is proportional to the length of these bobbins or electro-magnets.

If we make a drawing of six Gramme rings of equal size, connected up in the usual way, and on the first ring indicate 24 bobbins; on the second, 18 bobbins; on the third, 12 bobbins; on the fourth, 6 bobbins; on the fifth, 4 bobbins; and on the sixth ring, 2 bobbins; we shall see an interesting transition from the so-called continuous current ring of 24 bobbins to the decidedly alternating one with the 2 bobbins only, the last being similar to a Griscom armature connected up in parallel.

M. F. de Wolffers' gratuitous but unnecessary remarks on my patent in your last issue must be taken for what they are worth. It is a question whether it is the proper thing for those who thrust unconsidered schemes before the public, and then, when they meet with opposition, to make hasty remarks which are calculated to depreciate valuable property in the eyes of those who cannot be expected to know the value of those remarks. Personally, I think—judging from M. F. de Wolffers' recent contributions—that gentleman has a deal to learn, or perhaps unlearn, before his electrical views can be thought to have much weight.

E. L. Voice.

1, Francis Street, W.C.,
June 30th, 1884.

The Centre of Action of Galvanometer Coils.

In galvanometers it is sometimes necessary to know the hypothetical distance, "D," of a turn of wire in which, if all the coils of wire of the galvanometer were supposed to be compressed, the deflection on the needle in the centre of the coil would be the same; this distance, which might be termed "the centre of action of the coil" (in the same way as the terms centre of oscillation and gyration are used in dynamics), may be either found by calculation or experiment. In coils with little breadth and depth as compared with their distance from the centre of the needle, the centre of action of the coil would correspond with the mean distance of the coils of wire, that is, x_3 in fig. 1, and in galvanometers that have considerable depth and but

FIG. 1.

FIG. 2.

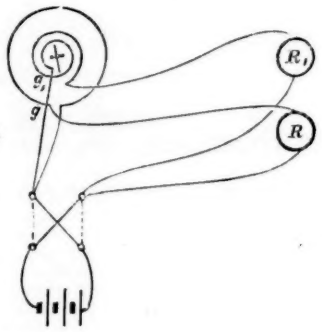


FIG. 3.

little breadth, this distance would be rather nearer than the mean distance of the coils of wire; the action of all the turns of wire upon the needle would equal

$$\int_{x_1}^{x_2} \frac{1}{x}\, d\,x = \log.\, \epsilon \frac{x_2}{x_1}$$

and this would equal

$$\left(\frac{x_2 - x_1}{\mathrm{D}_1}\right)$$

$$\therefore \quad \mathrm{D}_1 = \frac{x_2 - x_1}{\log.\, \epsilon \frac{x_2}{x_1}}$$

But in galvanometers that have a breadth as well as a depth, as in fig. 2, the centre of action would be more difficult to calculate, and might be much more quickly and accurately found by experiment.

In fig. 3 let g be a coil whose centre of action, D, has been determined, and let g_1 be a coil whose centre of action it is required to determine; let g have n turns of wire and g_1 have n_1 turns of wire, then when the resistance, R and R_1, are so adjusted that each coil produces an equal and opposite effect upon the needle

$$\frac{\mathrm{D}_1\, n_1}{g_1 + \mathrm{R}_1} = \frac{\mathrm{D}\, n}{g + \mathrm{R}}$$

$$\therefore \quad \mathrm{D}_1 = \mathrm{D}\, \frac{n\,(g_1 + \mathrm{R}_1)}{n_1\,(g + \mathrm{R})}$$

W. Moon.